CHAPTER 620
RIGID PAVEMENT

Topic 621 - Types of Rigid Pavements

Index 621.1 - Continuously Reinforced Concrete Pavement (CRCP)

CRCP uses reinforcement rather than transverse joints for crack control. Longitudinal joints are still used. Transverse random cracks are expected in the slab, usually at 3 to 7-foot intervals (see Figure 621.1). The continuous reinforcement in the pavement holds the cracks tightly together.

CRCP is the preferred concrete pavement type for new construction and concrete overlays for TI ≥ 13.0 in all climate regions except High Mountain and High Desert. It may also be used for widening and replacement of existing lanes where there is adequate space to construct.

CRCP may cost more initially than other types of cast in place pavement due to the added cost of the reinforcement, but is typically more cost-effective over the life of the pavement on high volume routes due to improved long-term performance and reduced maintenance.

Because there are no sawn transverse joints, CRCP should provide better ride quality and less maintenance than Jointed Plain Concrete Pavement (JPCP).

Additional CRCP guidance can be found in the "Concrete Pavement Guide" on the Department's Pavement website.

621.2 Jointed Plain Concrete Pavement (JPCP)

JPCP is the most common type of rigid pavement used by the Department. JPCP uses longitudinal and transverse joints to control where cracking occurs in the slabs (see Figure 621.1), and does not contain reinforcement other than tie bars and dowel bars (see Index 622.4). JPCP is preferred for lower volume truck routes (TI < 13.0), ramps, urban streets, pavements in High Mountain and High Desert climate regions and on widened and rehabilitated pavements where there is not sufficient space to construct CRCP.

Additional guidance for JPCP can be found in the "Guide for Design and Construction of New Jointed Plain Concrete Pavements" on the Department Pavement website.

621.3 Precast Panel Concrete Pavement (PPCP)

PPCPs use panels that are precast off-site instead of cast-in-place. The precast panels can be linked together with dowel bars and tie bars or can be post-tensioned after placement. PPCP can offer the advantages of:

- Improved concrete mixing and curing in a precast yard.
- Reduced pavement thicknesses when post tensioned, which is beneficial when there are profile grade restrictions such as vertical clearances.
- Shorter lane closure times, which is beneficial when there are short construction windows.

The primary disadvantage of PPCP is the high cost of precasting, transportation and installation. PPCP also needs a smoothly leveled base underneath the precast panels during construction to even out the loads on the slab and avoid uneven deflection that could lead to faulting at the joints, slab settlement, and/or premature cracking. PPCP is currently used on an experimental basis in California, and must follow the procedures for experimental projects and special designs discussed in Topic 606.

Topic 622 - Engineering Requirements

622.1 Engineering Properties

The predominant type of concrete used in California for rigid pavement is portland cement concrete. Other types of hydraulic cement concrete are sometimes used for special considerations such as rapid strength concrete.

Table 622.1 shows the concrete engineering properties that were used to develop the rigid pavement design catalog in this chapter. The

Figure 621.1

Types of Rigid Pavement

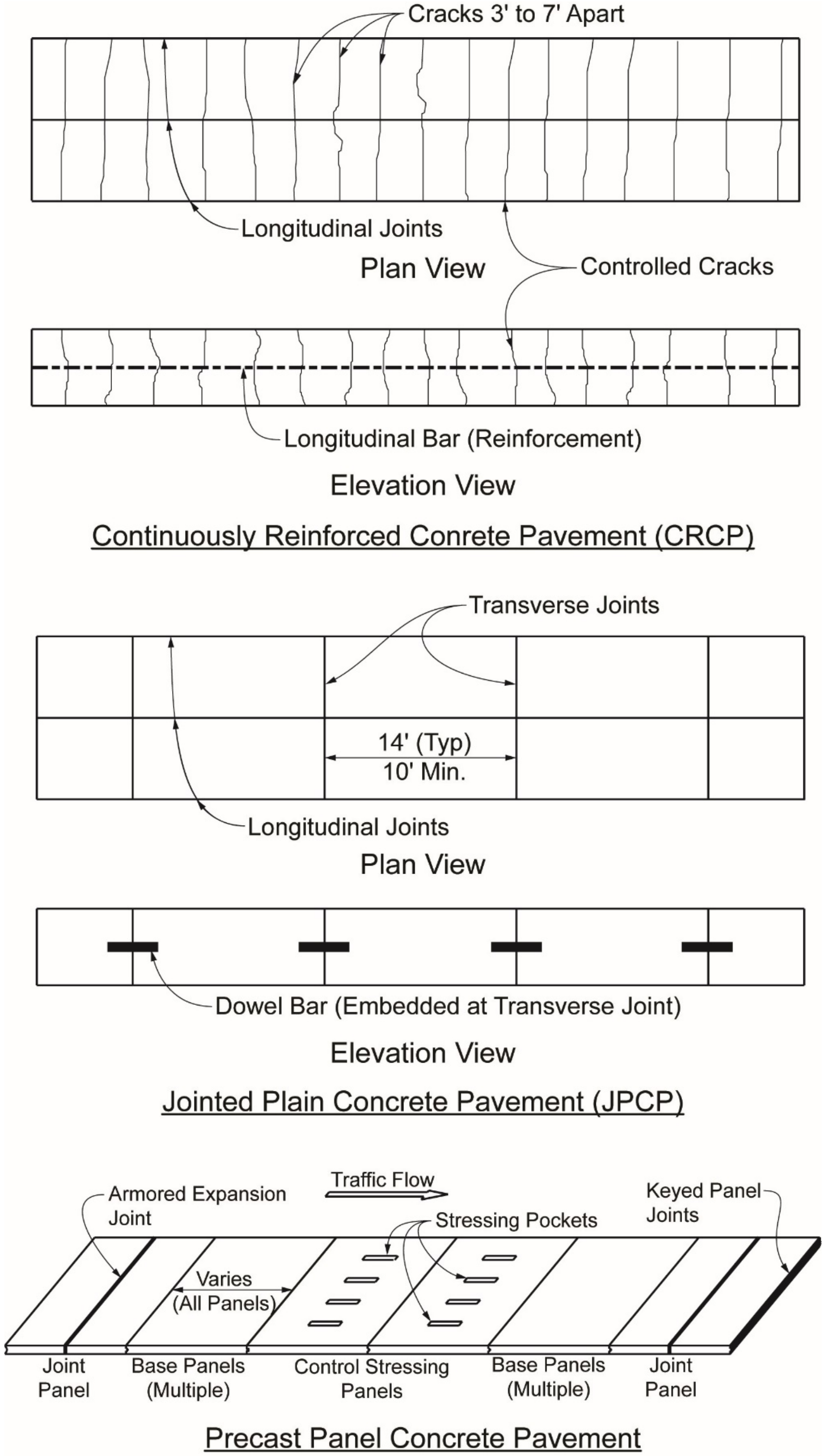


Table 622.1

Concrete Properties Used in Developing Rigid Pavement Design Catalog

Property	Values
Transverse joint spacing	14 ft average
Initial IRI immediately after construction	63 in/mile max
Reliability	90%
Unit weight	150 lb/ft^3
Poisson's ratio	0.20
Coefficient of thermal expansion	5.5 x 10^{-6}/ °F
Thermal conductivity	$1.25 \frac{\text{Btu}}{\text{hr - ft - °F}}$
Heat capacity	$0.28 \frac{\text{Btu}}{\text{lbm - °F}}$
Permanent curl/warp effective temperature difference	Top of slab is 10 °F cooler than bottom of slab
Surface layer/base interface	Unbonded
Surface shortwave absorptivity	0.85
Cement type	Type II Portland Cement
Cement material content (cement + flyash)	24 lb/ft^3
Water: cementitious material ratio	0.42
PCC zero-stress temperature	100.9 °F
Ultimate shrinkage at 40% relative humidity	537 microstrain
Reversible shrinkage (% of ultimate shrinkage)	50%
Time to develop ultimate shrinkage	35 days
Modulus of rupture or flexural strength (28 days)	625 psi
Dowel bar diameter	1.5 in (1.25 in for rigid pavement thickness < 0.70 ft)

values are based on Department specifications and experience with materials used in California.

622.2 Performance Factors

The end-of-design life performance factors used to develop concrete pavement structure design catalogs found in this chapter are presented in Table 622.2. The design catalogs are intended to ensure that concrete pavements are engineered to meet or exceed the performance factors in Table 622.2 (i.e., the pavement structure will last longer before reaching these thresholds).

Table 622.2

Concrete Pavement Performance Factors

Factor	Value
General	
Design Life	Determined per Topic 612
Terminal IRI [(1)] at end of design life	170 in/mile max
JPCP only	
Transverse cracking at end of design life	10% of slabs max
Longitudinal cracking at end of design life	10% of slabs max
Corner cracking at end of design life	10% of slabs max
Average joint faulting at end of design life	0.10 inch max
CRCP only	
Punchouts at end of design life	10 per mile max

NOTE:

(1) The International Roughness Index (IRI) is a nationally recognized method for measuring the smoothness of pavements.

622.3 Types of Concrete

(1) *Portland Cement Concrete (PCC).* Portland cement concrete is the most common concrete used. It is composed of portland cement, supplementary cementitious materials, aggregate, water and sometimes chemical admixtures. It is typically produced by weighing materials in batches that are charged into a rotary drum mixer. For pavements, the mixer is usually stationary and the concrete is loaded into dump trucks for delivery. The concrete is normally placed and consolidated using a paving machine which incorporates internal vibrators, grade control and the screed among other things. Initial setting of the concrete is normally about 4 to 6 hours; however, accelerators can be added to make the time much shorter. Strength gain allows the pavement to be opened to traffic in about 10 days and continues to increase for an extended period. Portland cement concrete is designed to resist environmentally induced degradation for over 100 years. Typical use for portland cement concrete is new pavement, widening, reconstruction and rehabilitation.

(2) *Rapid Strength Concrete (RSC).* Rapid strength concrete is used in cases where rapid construction (typically 3 days or less) and accelerated opening to traffic is the most important consideration. RSC is either highly accelerated portland cement concrete without supplementary cementitious materials or concrete made with a proprietary hydraulic cement which sets and gains strength extremely fast. It is produced either by weighing batches that are charged into a rotary drum mixer truck and then accelerated with chemicals at the pavement site or by volumetric proportioning and continuous mixing at the pavement site. The concrete is typically placed into forms or an excavated area and consolidated using hand held vibrators. Finishing is normally done with a roller screed and hand tools. The final finish is typically rougher than portland cement concrete and grinding to achieve smoothness may be needed. Strength gain allows the pavement to be opened to traffic in hours where it continues to gain strength for several days. Rapid strength concrete is designed for rapid return to service. Because these products are

relatively new to pavements, their long-term durability (40 or more years) has yet to be substantiated. Typical use for rapid strength concrete is individual slab replacement, punch-out repair, reconstruction or widening in locations where traffic cannot be diverted for at least 10 days.

(3) *Roller Compacted Concrete (RCC).* Roller compacted concrete is portland cement concrete that is produced with water content diminished to the point that it must be consolidated with a vibratory roller, similar to asphalt pavement. The initial finish looks similar to an HMA surface. It is typically produced by volumetric proportioning and continuous mixing in a stationary plant and the concrete is loaded into dump trucks for delivery. The concrete is placed and shaped by a paving machine similar to an asphalt paving machine in lifts up to 0.80 ft. The concrete is compacted by a 10 ton vibratory roller. It is not as smooth as pavement placed with concrete paving machines. Strength gain allows the pavement to be opened to light traffic in 24 hours and heavy traffic (trucks) in 3 days. It will continue to gain strength for an extended period. Roller compacted concrete is designed to resist environmentally induced degradation for over 100 years. Roller compacted concrete is only used on State highways for shoulders and temporary detours.

622.4 Pavement Joints

(1) *Construction.* Construction joints are joints between sections of concrete slabs that result when concrete is placed at different times. Construction joints can be transverse or longitudinal and are constructed in all types of concrete pavements. Except for precast pavement, the joint is formed by placing a metal or wooden header board that is set vertical to the surface and at right angle or parallel to the centerline and it is of sufficient length and height so that it conforms to the cross section of the pavement.

For CRCP, construction joints allow for some paving breaks in the continuous concrete paving operation. On a subsequent paving day the joints are used to extend the pavement in-kind. Transverse construction joints typically include additional longitudinal reinforcement to keep construction cracks from widening. Holes are drilled in the header board to allow the longitudinal reinforcing bars to pass through the header board.

For JPCP, construction joints occur at planned transverse joints and longitudinal joints. They are typically placed by the contractor to facilitate their paving operation. Details and instructions for how to place construction joints in JPCP are found in the Standard Plans and Standard Specifications. Tie bars are typically used at longitudinal construction joints to connect the adjoining slabs together so that the construction joint will be tightly closed. Dowel bars are used at transverse construction joints to provide load transfer.

(2) *Contraction.* Longitudinal and transverse contraction joints (also known as weakened plane joints) are sawed into new pavement to control the location and geometry of shrinkage, curling, and thermal cracking.

CRCP is constructed without transverse contraction joints. Transverse cracks are allowed to form but are held tightly together with continuous reinforcing steel for crack formation.

JPCP contains contraction joints that create a weakened line across the slab to control the location of the expected natural cracks. The concrete is supposed to crack at the contraction joints and not elsewhere in the slabs. The Standard Plans show the typical spacing details for transverse contraction joints. For special situations, such as intersections, spacing layout will be needed. See HDM Index 626.3 for special consideration when engineering a rigid pavement intersection.

Contraction joints are not integral parts in the construction of tensioned PPCP.

(3) *Isolation.* Isolation joints are used to separate dissimilar pavements/structures in order to reduce compressive stresses that could cause cracking. Examples of dissimilar pavements/structures include different joint patterns, different types of rigid pavement (e.g., CRCP/JPCP), structure foundations, drainage inlets, drainage inlet depressions, manholes and

manhole frame and cover. Isolation joints keep cracks from propagating through the joint and are sealed to prevent water/dirt infiltration. Isolation joints are most commonly placed along pavement longitudinal joints. Because of different arrangements for structure foundations, drainage inlets, drainage inlet depressions, and utility frames and covers, isolation joints are necessary to provide isolation to relieve stresses in the abutting faces of dissimilar pavements/structures.

(4) *Expansion.* Expansion joints are used in CRCP where there is a need to allow for a large expansion, greater than one half inch, between slabs or pavements. They are typically placed in the transverse direction. Like isolation joints, expansion joints are sealed to prevent water and dirt infiltration. For CRCP, expansion joints are typically used where CRCP abuts up to bridges, structure approach slabs or other types of rigid pavements. Expansion joints are also used with PPCP formed at the end of the slab to accommodate the expansion and contraction movements of the pavement. Expansion joints are typically not used with JPCP.

Typical joint spacing patterns can be found in the Standard Plans. In some cases such as intersections and parking lots, joint spacing patterns need to be engineered and included on project construction details. See Topic 626 for further details.

622.5 Transitions Panels, Terminal Joints and Anchors

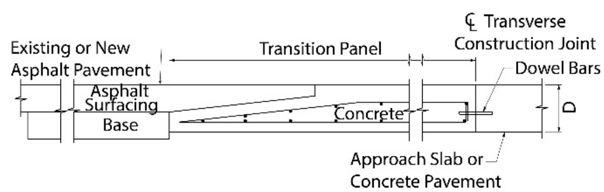
Transition panels and anchors are used at transverse joints to minimize deterioration or faulting of the joint where rigid pavement abuts to flexible pavement, a different type of rigid pavement, or a structure approach. The following types of transition joints and anchors should be used where applicable:

(1) *Concrete Pavement Transition Panel.* The concrete pavement transition panel is used to provide a smooth transition between concrete and asphalt pavements (see Figure 622.5A) by minimizing distortion of asphalt at the joint. It can also be used as a transition between structure approach slabs and asphalt pavement. The transition panel is a 12-foot long reinforced concrete panel placed between the existing or new asphalt pavement and the concrete pavement or approach slab. It is not always possible to build this panel due to short construction windows and limited space. Where building this panel is not possible, a JPCP End Anchor or CRCP Transition Joint Type A or C should be used.

(a) End Anchor - Use when JPCP abuts to asphalt or composite pavement and Concrete Pavement Transition Panel is not used. Also recommended where JPCP abuts to structure approach slabs. Consists of a 14-foot long end panel which varies in thickness from the designed thickness to 2 feet. Base type and thickness under the end anchor is the same as base under JPCP.

Figure 622.5A

Concrete Pavement to Asphalt Pavement Transition Panel



(2) *Continuously Reinforced Concrete Pavement.* **For CRCP, terminal joints and expansion joints shall be used at all transitions to or from structure approach slabs, or other pavement type as shown in Table 622.5. Where a construction joint is not used to connect two segments of CRCP, an expansion joint shall be used.** Where indicated in Table 622.5 use a wide flange beam or pavement anchor. Expansion joints and sometimes anchors or wide flange beams that are needed to accommodate and minimize the movement of the end of a CRCP section. The Standard Plans include a variety of details for these transitions and terminal anchors.

Depending on the CRCP terminal type to be used, Figures 622.5B and 622.5C show the schematic diagrams of Pavement Anchor, Wide Flange Beam, and Expansion Joint sequential connection between CRCP and existing structure approach slab or other types of pavement.

Table 622.5

Use of Terminal Joints, Expansion Joint, Wide Flange Beam, and Anchors in CRCP

Type	Length of CRCP		
	< 2000 feet	> 2000 feet	
		Grade <3%	Grade >3%
Terminal Joint	Yes	Yes	Yes
Expansion Joint	Yes(1)	Yes	Yes
Wide Flange Beam	No	Yes(2)	No
Pavement Anchor	No	No	Yes(3)

NOTES:

(1) Can provide one side only when CRCP section is ≤ 500 feet.

(2) Can provide on one side only when CRCP section is ≤ 1 mile.

(3) Provide one anchor lug per percent of grade up to maximum of 5.

The following types of joints and anchors are used for CRCP:

(a) Terminal Joints – Terminal joints are used in CRCP to transition to another pavement type or to a structure approach slab. It is found at the beginning and end of all CRCP. Its function is to isolate CRCP and adjacent pavement types or approach slab to prevent damage and faulting at the transverse joint. The following are terminal joint types for CRCP:

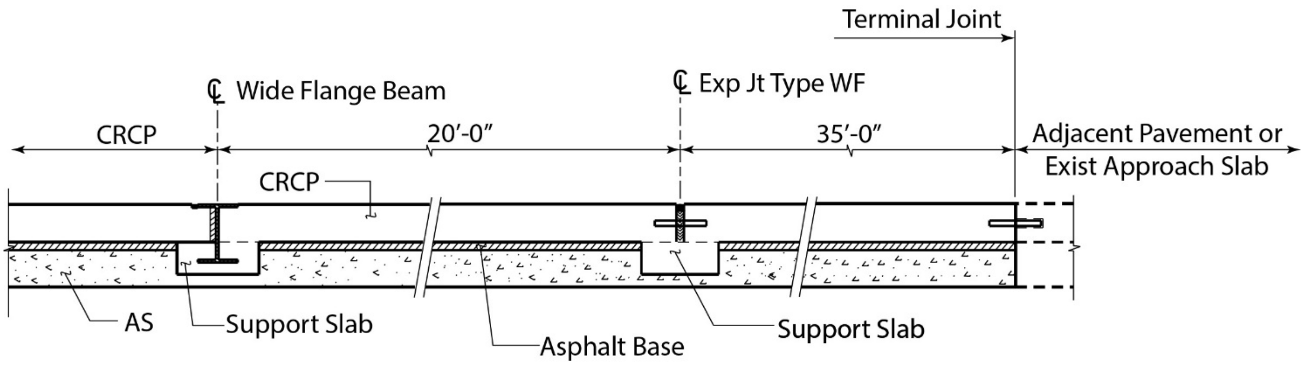
- Terminal Joint Type (A) - Use when constructing new CRCP next to existing asphalt pavement and if a concrete pavement transition panel is not viable.
- Terminal Joint Type (B) - Use when the newly constructed CRCP terminates at future pavement construction. CRCP at the terminus will be supported with a reinforced concrete support slab and backfilled with backing material and later removed when the new pavement will be constructed.
- Terminal Joint Type (C) - Use when the newly constructed CRCP terminates at a proposed temporary asphalt pavement construction for traffic staging. CRCP at the terminus will be supported with a reinforced concrete support slab.
- Terminal Joint Type (D) - Use when constructing new CRCP next to existing JPCP, PPCP, or structure approach slab.
- Terminal Joint Type (E) - Use when constructing new CRCP next to new JPCP, PPCP, or structure approach slab.

(b) Expansion Joint - Expansion joint is a full depth, full width transverse joint designed to absorb the pavement expansion without damaging adjacent structures. The expansion joint is used in combination with transition joints (see Figures 622.5B and 622.5C). The use of an expansion joint by itself is economical compared to a pavement anchor or wide flange beam terminal in CRCP pavement sections that are less than 2000 feet where pavement terminates at structure approach slab, or other types of pavements.

(c) Wide-Flange Beam - Wide flange beam is a joint that allows the end of the CRCP slab to expand. The wide flange beam is set in a 10-foot long support slab. The top flange of the beam is flush with the pavement surface. An expansion joint, type WF and terminal joint is used in combination with the wide flange beam (see Figure 622.5B).

Figure 622.5B

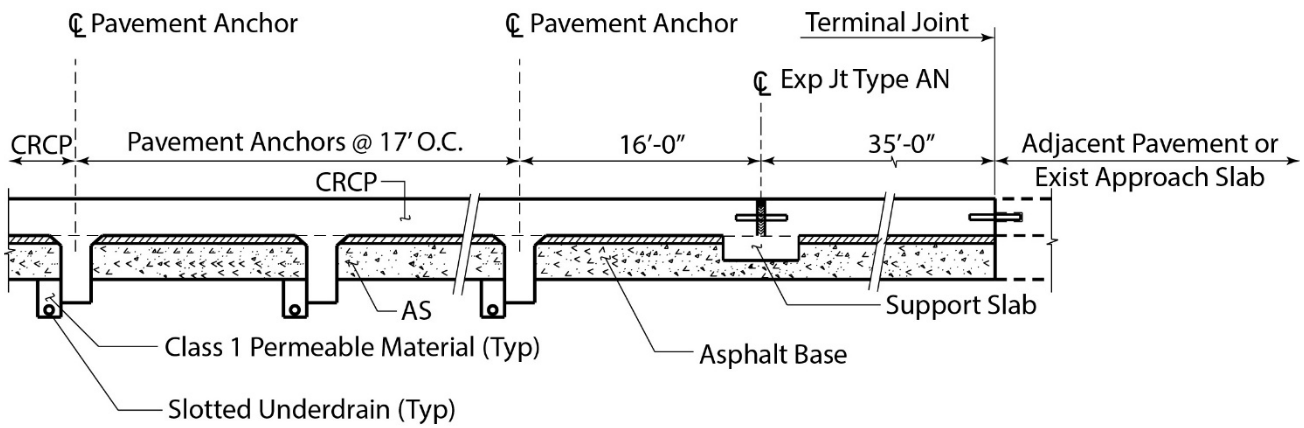
Wide Flange Connection Between CRCP and Existing Pavement or Structure Approach Slab



NO SCALE

Figure 622.5C

Pavement Anchor Connection Between CRCP and Existing Pavement or Structure Approach Slab



NO SCALE

NOTES:

(1) Pavement anchor shown is for 5-lug system. Number of lugs varies depending on project requirements (See Table 622.5)

Wide flange beams are not used with pavement anchors. Do not use wide flange beams in high mountain or high desert climate regions or anywhere else where it is expected to grind more than ½ inch of concrete during the service life of the joint.

(d) Pavement Anchor - Pavement anchors (also referred to as anchor lugs) are used to restrict downhill movement in grades of 3 percent or more. Pavement anchors consist of heavily reinforced rectangular transverse concrete lugs that are integrally constructed with the CRCP (see Figure 622.5C). The anchors are placed in the subgrade without forms underneath the pavement prior to placement of the pavement. The standard spacing of the lugs is 17 feet center to center from the expansion joint or each other. The pavement anchor is used in combination with an expansion joint and terminal joint (see Figure 622.5C). Pavement anchors are not used with wide flange beams.

Table 622.5 identifies circumstances for where to use terminal joints, expansion joints, pavement anchors, and wide flange beams.

(3) *Jointed Plain Concrete Pavement.* The following types of transition joints and anchors are used only for JPCP:

(a) Terminal Joint Type 1 – Use when constructing new JPCP next to existing concrete pavement or structure approach slab. It consists of a transverse construction joint with dowel bars drilled and bonded to existing concrete.

(b) Terminal Joint Type 2 – Use when constructing new JPCP next to new structure approach slabs or concrete to asphalt transition panel. It consists of a transverse construction joint with dowel bars placed at the joint of new concrete pavement or structure approach slabs and the new concrete.

622.6 Joint Seals

(1) *General.* Joint and crack seals are used to protect wide joints (joints 3/8 inch or wider) from infiltration of surface moisture and intrusion of incompressible materials. Infiltration of surface moisture and intrusion of incompressible materials into joints is minimized when a narrow joint is used.

(2) *New Construction, Widening, and Reconstruction.* Joints are not sealed for new construction, widening, or for reconstruction except for the following conditions:

- isolation joints,
- expansion joints,
- longitudinal construction joints in all desert and mountain climate regions, and
- transverse joints in JPCP in all desert and mountain climate regions.

(3) *Preservation and Rehabilitation.* To be effective, existing joint seals should be replaced every 10 to 15 years depending on the type used. As part of preservation or rehabilitation strategies, existing joint seals should be replaced when the pavement is ground, replaced or dowel bar retrofitted. Previously unsealed joints should be reviewed to determine if joint sealing is warranted in accordance with the criteria in the Maintenance Technical Advisory Guide. The condition of the existing joints and joint seals should be reviewed with the District Maintenance Engineer to determine if joint seal replacement is warranted.

(4) *Selection of Joint Seal Material.* Various products are available for sealing joints with each one differing in cost and service life. The type of joint sealant is selected based on the following criteria:

- Project environment.

  In mountain and high desert climate regions where chains are used during winter storms, joint sealants that use backer rods are not recommended. Severe climate conditions (such as in the mountains or deserts) will require more durable sealants and/or more frequent replacement.

- Type of roadway.

Interstate or State highway, and corresponding traffic characteristics including traffic volumes and percentage of truck traffic.

- Condition of existing reservoir.

  If the sides of in-place joint faces are variable in condition, do not use preformed compression seal.

- Expected performance.

  If suitable for intended use and site conditions, the sealant with the longest service life is preferred.

  The joint sealant selected should match the type of existing joint sealant being left in place.

- Cost effectiveness.

  Life cycle cost analysis (LCCA) is used to select the appropriate sealant type.

  Joint sealants should not last longer than the pavement being sealed.

For additional information on various joint seal products and selection guidance, consult the Maintenance Technical Advisory Guide on the Department Pavement website.

622.7 Dowel Bars and Tie Bars

(1) Dowel bars are smooth round bars that act as load transfer devices across pavement joints.

Dowel bars shall be placed within the traveled way pavement structure at the following joints:

- **All transverse expansion joints in CRCP.**
- **All transverse contraction and construction joints in JPCP.**
- **All transverse expansion joints in PPCP and at construction joints where post tensioning is not performed.**
- **All transverse transition joints regardless of concrete pavement type where concrete pavement abuts to structure approach slabs or other concrete pavement type.**

Dowel bars should not be used on shoulders except within the limits of widened slabs and for tied concrete shoulders that are engineered to be converted to a future lane in conformance with Index 613.5(2). When dowel bars are used, they must meet the same requirements as the traveled way.

For individual slab replacements, the placement of dowel bars is determined on a project-by-project basis based on proposed design life, condition or remaining service life of adjacent slabs, whether original pavement was constructed doweled or undoweled, and other pertinent factors. Since individual slab replacements are meant to extend service life of the existing pavement structure for less than 20 years, doweling contraction joints is not cost effective. Details for doweling slab replacements for JPCP can be found in the Standard Plans.

In limited situations, dowel bars are placed across longitudinal joints. See Standard Plans for further details.

(2) Tie Bars. Tie bars are deformed bars (i.e., rebar) or connectors that are used to hold the faces of abutting rigid slabs in contact. Tie bars are typically placed across longitudinal joints. **Tie bars shall be placed at longitudinal joints except at the following locations:**

- Adjacent concrete pavement when the spacing of transverse joints of adjacent slabs is not the same.
- Roller compacted concrete or post tensioned PPCP.
- Do not tie more than 50 feet width of JPCP together to preclude random longitudinal cracks from occurring due to the pavement acting as one large rigid slab. In order to maintain some load transfer across the longitudinal joint, the Standard Plans include details for placing dowel bars in the longitudinal joint within the travelled way for this situation.
- Individual slab replacements.

Further details regarding tie bars can be found in the Standard Plans.

622.8 Base Bond Breaker

When concrete pavement is placed on a concrete base without an engineered bond breaker uncontrolled bonding can occur. In areas of bonding, the pavement and base act as a monolithic mass causing sawn joints to be ineffective due to insufficient depth. This causes cracks to occur in the pavement surface in unexpected areas. To prevent bonding and subsequent crack formation, use a base bond breaker between concrete pavement and concrete bases, including lean concrete base, cement treated permeable base, and cement treated base.

Several methods are available for using bond breaker including sufficient application of wax curing compound, geosynthetic, or asphalt binder. When using rapid strength concrete, plastic sheeting or paper may also be suitable alternatives. Asphalt pavement interlayers are not used as bond breakers because it is more efficient to use asphalt base for construction than require two separate products. The Standard Specifications and Standard Special Provisions provide the options for the Contractor to select. For design, the engineer needs to identify on the typical sections when base bond breaker is to be installed.

622.9 Texturing

Longitudinal tining is the typical texturing for new pavements. Grooving is typically done to rehabilitate existing pavement texture or to improve surface friction. Grinding is typically done to restore a smooth riding surface on existing pavements or for individual slab replacements.

622.10 Pavement Smoothness

Pavement smoothness, which is also referred to as ride quality, is an important surface texture characteristic that affects both long-term pavement performance as well as ride quality. Smoother pavements have lower dynamic loads and provide the following benefits:

- Improved ride quality;
- Extended pavement life;
- Reduced highway travel user costs, such as gas usage and wear and tear; and
- Lower pavement maintenance costs and less work zone activities.

Pavement smoothness, or ride quality, is measured in terms of the International Roughness Index (IRI). For new construction, reconstruction and widening projects, the concrete pavement is engineered and built to have an IRI of 60 inches per mile or less. For additional information, see the pavement smoothness page on the Department Pavement website.

Topic 623 - Engineering Procedure for New, Widening, and Reconstruction Projects

623.1 Catalog

Tables 623.1B through M contain the minimum thickness for concrete pavement surface layers, base, and subbase of the traveled way for all types of projects. All JPCP structures shown are doweled. The tables are categorized by subgrade soil type and climate regions. Figure 623.1 is used to determine which table to use to select the traveled way pavement structure. For pavement structure types at other locations such as shoulders and parking lots, see Topic 626.

The steps for selecting the appropriate concrete pavement structure are as follows:

(1) *Determine the Soil Type for the Existing Subgrade*. Soil types for existing subgrade are categorized into Types I, II, and III as shown in Table 623.1A. Soils are classified by the Unified Soil Classification System (USCS). If a soil can be classified in more than one type in Table 623.1A, then the engineer should choose the more conservative design based on the less stable soil. Subgrade is discussed in Topic 614.

(2) *Determine Climate Region*. Find the location of the project on the Pavement Climate Map. The Pavement Climate Map is discussed in Topic 615.

(3) *Select the Appropriate Table (Tables 623.1B through M).* Select the table that applies to the project based on subgrade soil type, and climate region. Use Figure 623.1 to determine which table applies to the project.

Table 623.1A

Relationship Between Subgrade Type(1)

Subgrade Type(2)	Unified Soil Classification System (USCS)
I	SC, SP, SM, SW, GC, GP, GM, GW
II	CH (PI ≤ 12), CL, MH, ML
III	CH (PI > 12)

NOTES:

(1) See Topic 614 for further discussion on subgrade and USCS.

(2) Choose more conservative soil type (i.e., use soil with a lower subgrade type) if native soil can be classified by more than one type.

Legend

PI = Plasticity Index

(4) *Determine Whether Pavement Has Lateral Support Along Both Longitudinal Joints*. The pavement is considered to have lateral support if any of the following exist:

- longitudinal joints are tied to an adjacent lane or shoulder,
- tied rigid shoulders are present, or
- a widened slab is present.

If lateral support is provided along only one longitudinal joint, then the pavement is considered to have no lateral support. As shown in Tables 623.1B through M, pavement thicknesses are reduced slightly for slabs engineered with lateral support along both longitudinal joints.

(5) *Select Pavement Structure*. Using the Traffic Index provided or calculated from the traffic projections, select the desired pavement structure from the list of alternatives provided.

Note that although the pavement structures listed for each Traffic Index are considered to be acceptable for the climate, soil conditions, and design life desired, they should not be considered as equal designs. Some designs will perform better than others, have lower maintenance/repair costs, and/or lower construction life-cycle costs. For these reasons, the rigid pavement structures in these tables cannot be used as substitutes for the pavement structures shown in approved contract plans.

Topic 624 – Engineering Procedures for Pavement Preservation

624.1 Preventive Maintenance

Examples of rigid pavement preventive maintenance strategies include the following or combinations of the following:

- Seal random cracks.
- Joint seal, repair/replace existing joint seals.
- Dowel bar retrofit.
- Grinding or grooving to maintain ride quality and/or restore surface texture.
- Special surface treatments (such as methacrylate, hardeners, and others).

Rigid pavement preventive maintenance strategies are discussed further in the Concrete Pavement Guide.

624.2 Capital Pavement Maintenance (CAPM)

A CAPM project is warranted if any of the following criteria is met:

(1) *Continuously Reinforced Concrete Pavement*

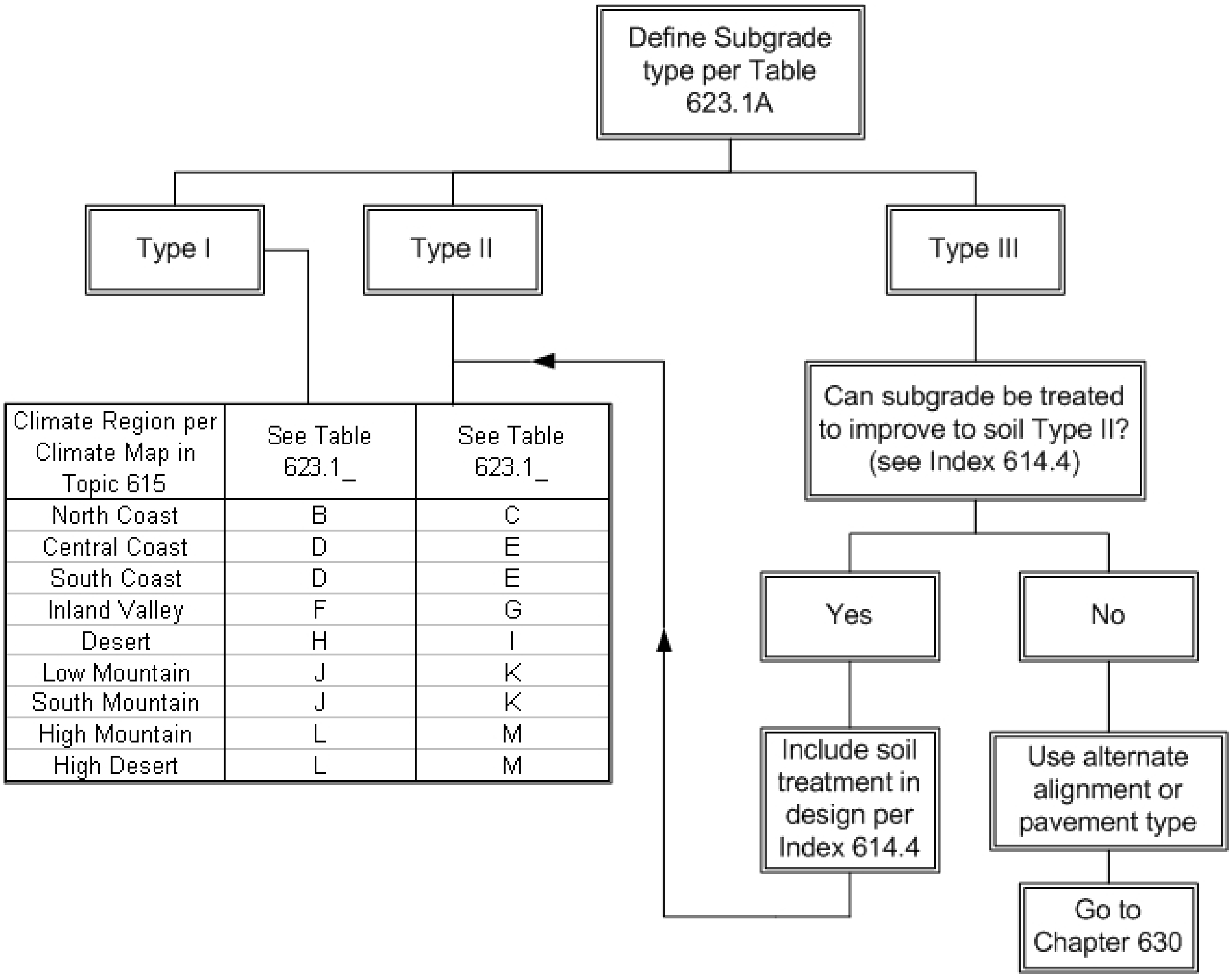
- Number of punchouts with high severity cracking is between 1 and 10 percent.

(2) *Jointed Plain Concrete Pavement*

- Number of slabs with 3rd stage cracking between 1 and 10 percent of a given travel lane-mile. Note, 3rd stage cracking is any slab with two or more intersecting cracks of at least ¾ inch in width.

Figure 623.1

Rigid Pavement Catalog Decision Tree



Climate Region per Climate Map in Topic 615	See Table 623.1_	See Table 623.1_
North Coast	B	C
Central Coast	D	E
South Coast	D	E
Inland Valley	F	G
Desert	H	I
Low Mountain	J	K
South Mountain	J	K
High Mountain	L	M
High Desert	L	M

Table 623.1B
Rigid Pavement Catalog (North Coast, Type I Subgrade Soil)(1), (2), (3), (4),(5)

	Rigid Pavement Structural Depth					
TI	With Lateral Support (ft)			Without Lateral Support (ft)		
≤ 9			0.70 JPCP 0.50 AB			0.70 JPCP 0.50 AB
9.5 to 10			0.75 JPCP 0.60 AB			0.75 JPCP 0.60 AB
10.5 to 11	0.70 JPCP BB 0.35 LCB	0.70 JPCP 0.25 HMA-A	0.75 JPCP 0.70 AB	0.75 JPCP BB 0.35 LCB	0.75 JPCP 0.25 HMA-A	0.80 JPCP 0.70 AB
11.5 to 12	0.75 JPCP BB 0.35 LCB	0.75 JPCP 0.25 HMA-A	0.75 CRCP 0.25 HMA-A	0.80 JPCP BB 0.35 LCB	0.80 JPCP 0.25 HMA-A	0.80 CRCP 0.25 HMA-A
12.5 to 13	0.80 JPCP BB 0.35 LCB	0.80 JPCP 0.25 HMA-A	0.75 CRCP 0.25 HMA-A	0.85 JPCP BB 0.35 LCB	0.85 JPCP 0.25 HMA-A	0.80 CRCP 0.25 HMA-A
13.5 to 14	0.80 JPCP BB 0.35 LCB	0.80 JPCP 0.25 HMA-A	0.75 CRCP 0.25 HMA-A	0.90 JPCP BB 0.35 LCB	0.85 JPCP 0.25 HMA-A	0.80 CRCP 0.25 HMA-A
14.5 to 15	0.85 JPCP BB 0.35 LCB	0.85 JPCP 0.25 HMA-A	0.80 CRCP 0.25 HMA-A	0.95 JPCP BB 0.35 LCB	0.95 JPCP 0.25 HMA-A	0.85 CRCP 0.25 HMA-A
15.5 to 16	0.90 JPCP BB 0.35 LCB	0.90 JPCP 0.25 HMA-A	0.85 CRCP 0.25 HMA-A	1.00 JPCP BB 0.35 LCB	1.00 JPCP 0.25 HMA-A	0.90 CRCP 0.25 HMA-A
16.5 to 17	0.95 JPCP BB 0.35 LCB	0.95 JPCP 0.25 HMA-A	0.85 CRCP 0.25 HMA-A	1.05 JPCP BB 0.35 LCB	1.05 JPCP 0.25 HMA-A	0.95 CRCP 0.25 HMA-A
> 17	1.00 JPCP BB 0.35 LCB	1.00 JPCP 0.25 HMA-A	0.90 CRCP 0.25 HMA-A	1.10 JPCP BB 0.35 LCB	1.10 JPCP 0.25 HMA-A	1.00 CRCP 0.25 HMA-A

NOTES:
(1) Thicknesses shown for JPCP are for doweled pavement only. The thickness shown in these tables are not valid for nondoweled JPCP.
(2) Includes 0.03 ft sacrificial wearing course for future grinding of JPCP/CRCP.
(3) Portland cement concrete may be substituted for LCB when justified for constructibility or traffic handling. If Portland cement concrete is used in lieu of LCB, it must be placed in a separate lift than JPCP and must not be bonded to the JPCP.
(4) If ATPB is needed for TIs > 10.0 to perpetuate an existing treated permeable layer, place the ATPB between the surface layer (JPCP or CRCP) and the base layer. No deduction is made to the thickness of the base and subbase layers on account of the ATPB.
(5) Place a Bond Breaker between JPCP and LCB in all cases

LEGEND:
JPCP = Jointed Plain Concrete Pavement
CRCP = Continuously Reinforced Concrete Pavement
LCB = Lean Concrete Base
HMA-A = Hot Mix Asphalt (Type A)
ATPB = Asphalt Treated Permeable Base
AB = Class 2 Aggregate Base
TI = Traffic Index
BB = Base Bond Breaker

Table 623.1C
Rigid Pavement Catalog (North Coast, Type II Subgrade Soil) (1), (2), (3), (4), (5)

TI	Rigid Pavement Structural Depth: With Lateral Support (ft)			Rigid Pavement Structural Depth: Without Lateral Support (ft)		
< 9			0.70 JPCP 1.00 AB			0.70 JPCP 1.00 AB
9.5 to 10			0.75 JPCP 1.00 AB			0.75 JPCP 1.00 AB
10.5 to 11	0.70 JPCP BB 0.35 LCB 0.60 AS	0.70 JPCP 0.25 HMA-A 0.60 AS	0.75 JPCP 1.30 AB	0.75 JPCP BB 0.35 LCB 0.60 AS	0.75 JPCP 0.25 HMA-A 0.60 AS	0.80 JPCP 1.30 AB
11.5 to 12	0.75 JPCP BB 0.35 LCB 0.60 AS	0.75 JPCP 0.25 HMA-A 0.60 AS	0.75 CRCP 0.25 HMA-A 0.60 AS	0.80 JPCP BB 0.35 LCB 0.60 AS	0.80 JPCP 0.25 HMA-A 0.60 AS	0.80 CRCP 0.25 HMA-A 0.60 AS
12.5 to 13	0.80 JPCP BB 0.35 LCB 0.70 AS	0.80 JPCP 0.25 HMA-A 0.70 AS	0.75 CRCP 0.25 HMA-A 0.70 AS	0.85 JPCP BB 0.35 LCB 0.70 AS	0.85 JPCP 0.25 HMA-A 0.70 AS	0.80 CRCP 0.25 HMA-A 0.70 AS
13.5 to 14	0.80 JPCP BB 0.35 LCB 0.70 AS	0.80 JPCP 0.25 HMA-A 0.70 AS	0.75 CRCP 0.25 HMA-A 0.70 AS	0.90 JPCP BB 0.35 LCB 0.70 AS	0.85 JPCP 0.25 HMA-A 0.70 AS	0.80 CRCP 0.25 HMA-A 0.70 AS
14.5 to 15	0.85 JPCP BB 0.35 LCB 0.70 AS	0.85 JPCP 0.25 HMA-A 0.70 AS	0.80 CRCP 0.25 HMA-A 0.70 AS	0.95 JPCP BB 0.35 LCB 0.70 AS	0.95 JPCP 0.25 HMA-A 0.70 AS	0.85 CRCP 0.25 HMA-A 0.70 AS
15.5 to 16	0.90 JPCP BB 0.35 LCB 0.70 AS	0.90 JPCP 0.25 HMA-A 0.70 AS	0.85 CRCP 0.25 HMA-A 0.70 AS	1.00 JPCP BB 0.35 LCB 0.70 AS	1.00 JPCP 0.25 HMA-A 0.70 AS	0.90 CRCP 0.25 HMA-A 0.70 AS
16.5 to 17	0.95 JPCP BB 0.35 LCB 0.70 AS	0.95 JPCP 0.25 HMA-A 0.70 AS	0.85 CRCP 0.25 HMA-A 0.70 AS	1.05 JPCP BB 0.35 LCB 0.70 AS	1.05 JPCP 0.25 HMA-A 0.70 AS	0.95 CRCP 0.25 HMA-A 0.70 AS
> 17	1.00 JPCP BB 0.35 LCB 0.70 AS	1.00 JPCP 0.25 HMA-A 0.70 AS	0.90 CRCP 0.25 HMA-A 0.70 AS	1.10 JPCP BB 0.35 LCB 0.70 AS	1.10 JPCP 0.25 HMA-A 0.70 AS	1.00 CRCP 0.25 HMA-A 0.70 AS

NOTES:

(1) Thicknesses shown for JPCP are for doweled pavement only. The thickness shown in these tables are not valid for nondoweled JPCP.

(2) Includes 0.03 ft sacrificial wearing course for future grinding of JPCP/CRCP.

(3) Portland cement concrete may be substituted for LCB when justified for constructibility or traffic handling. If Portland cement concrete is used in lieu of LCB, it must be placed in a separate lift than JPCP and must not be bonded to the JPCP.

(4) If ATPB is needed for TIs > 10.0 to perpetuate an existing treated permeable layer, place the ATPB between the surface layer (JPCP or CRCP) and the base layer. No deduction is made to the thickness of the base and subbase layers on account of the ATPB.

(5) Place a Bond Breaker between JPCP and LCB in all cases

LEGEND:

JPCP = Jointed Plain Concrete Pavement
CRCP = Continuously Reinforced Concrete Pavement
LCB = Lean Concrete Base
HMA-A = Hot Mix Asphalt (Type A)
BB = Base Bond Breaker
ATPB = Asphalt Treated Permeable Base
AB = Class 2 Aggregate Base
AS = Class 2 Aggregate Subbase
TI = Traffic Index

Table 623.1D
Rigid Pavement Catalog
(South Coast/Central Coast, Type I Subgrade Soil) (1), (2), (3), (4), (5)

TI	Rigid Pavement Structural Depth					
	With Lateral Support (ft)			Without Lateral Support (ft)		
≤ 9			0.70 JPCP 0.50 AB			0.75 JPCP 0.50 AB
9.5 to 10			0.75 JPCP 0.60 AB			0.80 JPCP 0.60 AB
10.5 to 11	0.75 JPCP BB 0.35 LCB	0.75 JPCP 0.25 HMA-A	0.80 JPCP 0.70 AB	0.80 JPCP BB 0.35 LCB	0.80 JPCP 0.25 HMA-A	0.85 JPCP 0.70 AB
11.5 to 12	0.80 JPCP BB 0.35 LCB	0.80 JPCP 0.25 HMA-A	0.80 CRCP 0.25 HMA-A	0.85 JPCP BB 0.35 LCB	0.85 JPCP 0.25 HMA-A	0.80 CRCP 0.25 HMA-A
12.5 to 13	0.85 JPCP BB 0.35 LCB	0.85 JPCP 0.25 HMA-A	0.80 CRCP 0.25 HMA-A	0.90 JPCP BB 0.35 LCB	0.90 JPCP 0.25 HMA-A	0.85 CRCP 0.25 HMA-A
13.5 to 14	0.85 JPCP BB 0.35 LCB	0.85 JPCP 0.25 HMA-A	0.80 CRCP 0.25 HMA-A	0.95 JPCP BB 0.35 LCB	0.95 JPCP 0.25 HMA-A	0.90 CRCP 0.25 HMA-A
14.5 to 15	0.90 JPCP BB 0.35 LCB	0.90 JPCP 0.25 HMA-A	0.85 CRCP 0.25 HMA-A	1.00 JPCP BB 0.35 LCB	1.00 JPCP 0.25 HMA-A	0.95 CRCP 0.25 HMA-A
15.5 to 16	0.95 JPCP BB 0.35 LCB	0.90 JPCP 0.25 HMA-A	0.85 CRCP 0.25 HMA-A	1.05 JPCP BB 0.35 LCB	1.05 JPCP 0.25 HMA-A	0.95 CRCP 0.25 HMA-A
16.5 to 17	1.00 JPCP BB 0.35 LCB	0.95 JPCP 0.25 HMA-A	0.90 CRCP 0.25 HMA-A	1.10 JPCP BB 0.35 LCB	1.10 JPCP 0.25 HMA-A	1.00 CRCP 0.25 HMA-A
> 17	1.05 JPCP BB 0.35 LCB	1.05 JPCP 0.25 HMA-A	0.95 CRCP 0.25 HMA-A	1.15 JPCP BB 0.35 LCB	1.15 JPCP 0.25 HMA-A	1.00 CRCP 0.25 HMA-A

NOTES:

(1) Thicknesses shown for JPCP are for doweled pavement only. The thickness shown in these tables are not valid for nondoweled JPCP.

(2) Includes 0.03 ft sacrificial wearing course for future grinding of JPCP/CRCP.

(3) Portland cement concrete may be substituted for LCB when justified for constructibility or traffic handling. If Portland cement concrete is used in lieu of LCB, it must be placed in a separate lift than JPCP and must not be bonded to the JPCP.

(4) If ATPB is needed for TIs > 10.0 to perpetuate an existing treated permeable layer, place the ATPB between the surface layer (JPCP or CRCP) and the base layer. No deduction is made to the thickness of the base and subbase layers on account of the ATPB.

(5) Place a Bond Breaker between JPCP and LCB in all cases

LEGEND:

JPCP = Jointed Plain Concrete Pavement
CRCP = Continuously Reinforced Concrete Pavement
LCB = Lean Concrete Base
HMA-A = Hot Mix Asphalt (Type A)
ATPB = Asphalt Treated Permeable Base
AB = Class 2 Aggregate Base
TI = Traffic Index
BB = Base Bond Breaker

Table 623.1E
Rigid Pavement Catalog
(South Coast/Central Coast, Type II Subgrade Soil) (1), (2), (3), (4), (5)

	Rigid Pavement Structural Depth					
TI	With Lateral Support (ft)			Without Lateral Support (ft)		
≤ 9			0.70 JPCP 1.00 AB			0.75 JPCP 1.00 AB
9.5 to 10			0.75 JPCP 1.00 AB			0.80 JPCP 1.00 AB
10.5 to 11	0.75 JPCP BB 0.35 LCB 0.60 AS	0.75 JPCP 0.25 HMA-A 0.60 AS	0.80 JPCP 1.30 AB	0.80 JPCP BB 0.35 LCB 0.60 AS	0.80 JPCP 0.25 HMA-A 0.60 AS	0.85 JPCP 1.30 AB
11.5 to 12	0.80 JPCP BB 0.35 LCB 0.60 AS	0.80 JPCP 0.25 HMA-A 0.60 AS	0.80 CRCP 0.25 HMA-A 0.60 AS	0.85 JPCP BB 0.35 LCB 0.60 AS	0.85 JPCP 0.25 HMA-A 0.60 AS	0.80 CRCP 0.25 HMA-A 0.60 AS
12.5 to 13	0.85 JPCP BB 0.35 LCB 0.70 AS	0.85 JPCP 0.25 HMA-A 0.70 AS	0.80 CRCP 0.25 HMA-A 0.70 AS	0.90 JPCP BB 0.35 LCB 0.70 AS	0.90 JPCP 0.25 HMA-A 0.70 AS	0.85 CRCP 0.25 HMA-A 0.70 AS
13.5 to 14	0.85 JPCP BB 0.35 LCB 0.70 AS	0.85 JPCP 0.25 HMA-A 0.70 AS	0.80 CRCP 0.25 HMA-A 0.70 AS	0.95 JPCP BB 0.35 LCB 0.70 AS	0.95 JPCP 0.25 HMA-A 0.70 AS	0.90 CRCP 0.25 HMA-A 0.70 AS
14.5 to 15	0.90 JPCP BB 0.35 LCB 0.70 AS	0.90 JPCP 0.25 HMA-A 0.70 AS	0.85 CRCP 0.25 HMA-A 0.70 AS	1.00 JPCP BB 0.35 LCB 0.70 AS	1.00 JPCP 0.25 HMA-A 0.70 AS	0.95 CRCP 0.25 HMA-A 0.70 AS
15.5 to 16	0.95 JPCP BB 0.35 LCB 0.70 AS	0.90 JPCP 0.25 HMA-A 0.70 AS	0.85 CRCP 0.25 HMA-A 0.70 AS	1.05 JPCP BB 0.35 LCB 0.70 AS	1.05 JPCP 0.25 HMA-A 0.70 AS	0.95 CRCP 0.25 HMA-A 0.70 AS
16.5 to 17	1.00 JPCP BB 0.35 LCB 0.70 AS	0.95 JPCP 0.25 HMA-A 0.70 AS	0.90 CRCP 0.25 HMA-A 0.70 AS	1.10 JPCP BB 0.35 LCB 0.70 AS	1.10 JPCP 0.25 HMA-A 0.70 AS	1.00 CRCP 0.25 HMA-A 0.70 AS
> 17	1.05 JPCP BB 0.35 LCB 0.70 AS	1.05 JPCP 0.25 HMA-A 0.70 AS	0.95 CRCP 0.25 HMA-A 0.70 AS	1.15 JPCP BB 0.35 LCB 0.70 AS	1.15 JPCP 0.25 HMA-A 0.70 AS	1.00 CRCP 0.25 HMA-A 0.70 AS

NOTES:

(1) Thicknesses shown for JPCP are for doweled pavement only. The thickness shown in these tables are not valid for nondoweled JPCP.

(2) Includes 0.03 ft sacrificial wearing course for future grinding of JPCP/CRCP.

(3) Portland cement concrete may be substituted for LCB when justified for constructibility or traffic handling. If Portland cement concrete is used in lieu of LCB, it must be placed in a separate lift than JPCP and must not be bonded to the JPCP.

(4) If ATPB is needed for TIs > 10.0 to perpetuate an existing treated permeable layer, place the ATPB between the surface layer (JPCP or CRCP) and the base layer. No deduction is made to the thickness of the base and subbase layers on account of the ATPB.

(5) Place a Bond Breaker between JPCP and LCB in all cases

LEGEND:

JPCP = Jointed Plain Concrete Pavement
CRCP = Continuously Reinforced Concrete Pavement
LCB = Lean Concrete Base
HMA-A = Hot Mix Asphalt (Type A)
BB = Base Bond Breaker
ATPB = Asphalt Treated Permeable Base
AB = Class 2 Aggregate Base
AS = Class 2 Aggregate Subbase
TI = Traffic Index

Table 623.1F
Rigid Pavement Catalog (Inland Valley, Type I Subgrade Soil) (1), (2), (3), (4), (5)

	Rigid Pavement Structural Depth					
TI	With Lateral Support (ft)			Without Lateral Support (ft)		
< 9			0.75 JPCP 0.50 AB			0.80 JPCP 0.50 AB
9.5 to 10			0.80 JPCP 0.60 AB			0.90 JPCP 0.60 AB
10.5 to 11	0.75 JPCP BB 0.35 LCB	0.75 JPCP 0.25 HMA-A	0.85 JPCP 0.70 AB	0.85 JPCP BB 0.35 LCB	0.90 JPCP 0.25 HMA-A	0.95 JPCP 0.70 AB
11.5 to 12	0.85 JPCP BB 0.35 LCB	0.85 JPCP 0.25 HMA-A	0.80 CRCP 0.25 HMA-A	0.95 JPCP BB 0.35 LCB	0.95 JPCP 0.25 HMA-A	0.85 CRCP 0.25 HMA-A
12.5 to 13	0.85 JPCP BB 0.35 LCB	0.90 JPCP 0.25 HMA-A	0.80 CRCP 0.25 HMA-A	1.00 JPCP BB 0.35 LCB	1.00 JPCP 0.25 HMA-A	0.90 CRCP 0.25 HMA-A
13.5 to 14	0.95 JPCP BB 0.35 LCB	0.95 JPCP 0.25 HMA-A	0.85 CRCP 0.25 HMA-A	1.05 JPCP BB 0.35 LCB	1.05 JPCP 0.25 HMA-A	0.95 CRCP 0.25 HMA-A
14.5 to 15	1.00 JPCP BB 0.35 LCB	1.00 JPCP 0.25 HMA-A	0.90 CRCP 0.25 HMA-A	1.15 JPCP BB 0.35 LCB	1.15 JPCP 0.25 HMA-A	1.00 CRCP 0.25 HMA-A
15.5 to 16	1.05 JPCP BB 0.35 LCB	1.05 JPCP 0.25 HMA-A	0.95 CRCP 0.25 HMA-A	1.20 JPCP BB 0.35 LCB	1.20 JPCP 0.25 HMA-A	1.05 CRCP 0.25 HMA-A
16.5 to 17	1.10 JPCP BB 0.35 LCB	1.10 JPCP 0.25 HMA-A	0.95 CRCP 0.25 HMA-A	1.25 JPCP BB 0.35 LCB	1.25 JPCP 0.25 HMA-A	1.10 CRCP 0.25 HMA-A
> 17	1.15 JPCP BB 0.35 LCB	1.15 JPCP 0.25 HMA-A	1.00 CRCP 0.25 HMA-A	1.30 JPCP BB 0.35 LCB	1.30 JPCP 0.25 HMA-A	1.10 CRCP 0.25 HMA-A

NOTES:
(1) Thicknesses shown for JPCP are for doweled pavement only. The thickness shown in these tables are not valid for nondoweled JPCP.
(2) Includes 0.03 ft sacrificial wearing course for future grinding of JPCP/CRCP.
(3) Portland cement concrete may be substituted for LCB when justified for constructibility or traffic handling. If Portland cement concrete is used in lieu of LCB, it must be placed in a separate lift than JPCP and must not be bonded to the JPCP.
(4) If ATPB is needed for TIs > 10.0 to perpetuate an existing treated permeable layer, place the ATPB between the surface layer (JPCP or CRCP) and the base layer. No deduction is made to the thickness of the base and subbase layers on account of the ATPB.
(5) Place a Bond Breaker between JPCP and LCB in all cases

LEGEND:
JPCP = Jointed Plain Concrete Pavement
CRCP = Continuously Reinforced Concrete Pavement
LCB = Lean Concrete Base
HMA-A = Hot Mix Asphalt (Type A)
ATPB = Asphalt Treated Permeable Base
AB = Class 2 Aggregate Base
TI = Traffic Index
BB = Base Bond Breaker

Table 623.1G
Rigid Pavement Catalog (Inland Valley, Type II Subgrade Soil) [(1), (2), (3), (4), (5)]

	Rigid Pavement Structural Depth					
TI	With Lateral Support (ft)			Without Lateral Support (ft)		
≤ 9			0.75 JPCP 1.00 AB			0.80 JPCP 1.00 AB
9.5 to 10			0.80 JPCP 1.00 AB			0.90 JPCP 1.00 AB
10.5 to 11	0.75 JPCP BB 0.35 LCB 0.60 AS	0.75 JPCP 0.25 HMA-A 0.60 AS	0.85 JPCP 1.30 AB	0.85 JPCP BB 0.35 LCB 0.60 AS	0.90 JPCP 0.25 HMA-A 0.60 AS	0.95 JPCP 1.30 AB
11.5 to 12	0.85 JPCP BB 0.35 LCB 0.60 AS	0.85 JPCP 0.25 HMA-A 0.60 AS	0.80 CRCP 0.25 HMA-A 0.60 AS	0.95 JPCP BB 0.35 LCB 0.60 AS	0.95 JPCP 0.25 HMA-A 0.60 AS	0.85 CRCP 0.25 HMA-A 0.60 AS
12.5 to 13	0.85 JPCP BB 0.35 LCB 0.70 AS	0.90 JPCP 0.25 HMA-A 0.70 AS	0.80 CRCP 0.25 HMA-A 0.70 AS	1.00 JPCP BB 0.35 LCB 0.70 AS	1.00 JPCP 0.25 HMA-A 0.70 AS	0.90 CRCP 0.25 HMA-A 0.70 AS
13.5 to 14	0.95 JPCP BB 0.35 LCB 0.70 AS	0.95 JPCP 0.25 HMA-A 0.70 AS	0.85 CRCP 0.25 HMA-A 0.70 AS	1.05 JPCP BB 0.35 LCB 0.70 AS	1.05 JPCP 0.25 HMA-A 0.70 AS	0.95 CRCP 0.25 HMA-A 0.70 AS
14.5 to 15	1.00 JPCP BB 0.35 LCB 0.70 AS	1.00 JPCP 0.25 HMA-A 0.70 AS	0.90 CRCP 0.25 HMA-A 0.70 AS	1.15 JPCP BB 0.35 LCB 0.70 AS	1.15 JPCP 0.25 HMA-A 0.70 AS	1.00 CRCP 0.25 HMA-A 0.70 AS
15.5 to 16	1.05 JPCP BB 0.35 LCB 0.70 AS	1.05 JPCP 0.25 HMA-A 0.70 AS	0.95 CRCP 0.25 HMA-A 0.70 AS	1.20 JPCP BB 0.35 LCB 0.70 AS	1.20 JPCP 0.25 HMA-A 0.70 AS	1.05 CRCP 0.25 HMA-A 0.70 AS
16.5 to 17	1.10 JPCP BB 0.35 LCB 0.70 AS	1.10 JPCP 0.25 HMA-A 0.70 AS	0.95 CRCP 0.25 HMA-A 0.70 AS	1.25 JPCP BB 0.35 LCB 0.70 AS	1.25 JPCP 0.25 HMA-A 0.70 AS	1.10 CRCP 0.25 HMA-A 0.70 AS
> 17	1.15 JPCP BB 0.35 LCB 0.70 AS	1.15 JPCP 0.25 HMA-A 0.70 AS	1.00 CRCP 0.25 HMA-A 0.70 AS	1.30 JPCP BB 0.35 LCB 0.70 AS	1.30 JPCP 0.25 HMA-A 0.70 AS	1.10 CRCP 0.25 HMA-A 0.70 AS

NOTES:

(1) Thicknesses shown for JPCP are for doweled pavement only. The thickness shown in these tables are not valid for nondoweled JPCP.

(2) Includes 0.03 ft sacrificial wearing course for future grinding of JPCP/CRCP.

(3) Portland cement concrete may be substituted for LCB when justified for constructibility or traffic handling. If Portland cement concrete is used in lieu of LCB, it must be placed in a separate lift than JPCP and must not be bonded to the JPCP.

(4) If ATPB is needed for TIs > 10.0 to perpetuate an existing treated permeable layer, place the ATPB between the surface layer (JPCP or CRCP) and the base layer. No deduction is made to the thickness of the base and subbase layers on account of the ATPB.

(5) Place a Bond Breaker between JPCP and LCB in all cases

LEGEND:

JPCP =	Jointed Plain Concrete Pavement	ATPB =	Asphalt Treated Permeable Base
CRCP =	Continuously Reinforced Concrete Pavement	AB =	Class 2 Aggregate Base
LCB =	Lean Concrete Base	AS =	Class 2 Aggregate Subbase
HMA-A =	Hot Mix Asphalt (Type A)	TI =	Traffic Index
BB =	Base Bond Breaker		

Table 623.1H
Rigid Pavement Catalog (Desert, Type I Subgrade Soil) (1), (2), (3), (4), (5)

	Rigid Pavement Structural Depth			
TI	With Lateral Support (ft)		Without Lateral Support (ft)	
≤ 9	0.75 JPCP 0.50 AB		0.80 JPCP 0.50 AB	
9.5 to 10	0.80 JPCP 0.60 AB		0.90 JPCP 0.60 AB	
10.5 to 11	0.85 JPCP 0.70 AB		0.95 JPCP 0.70 AB	
11.5 to 12	0.80 CRCP (6) 0.25 HMA-A (6)	0.90 JPCP (7) 0.70 AB (7)	0.85 CRCP (6) 0.25 HMA-A (6)	1.00 JPCP (7) 0.70 AB (7)
12.5 to 13	0.85 CRCP 0.25 HMA-A		0.95 CRCP 0.25 HMA-A	
13.5 to 14	0.90 CRCP 0.25 HMA-A		1.05 CRCP 0.25 HMA-A	
14.5 to 15	0.95 CRCP 0.25 HMA-A		1.10 CRCP 0.25 HMA-A	
15.5 to 16	1.00 CRCP 0.25 HMA-A		1.10 CRCP 0.25 HMA-A	
16.5 to 17	1.05 CRCP 0.25 HMA-A		1.10 CRCP 0.25 HMA-A	
> 17	1.10 CRCP 0.25 HMA-A		1.10 CRCP 0.25 HMA-A	

NOTES:

(1) Thicknesses shown for JPCP are for doweled pavement only. The thickness shown in these tables are not valid for nondoweled JPCP.

(2) Includes 0.03 ft sacrificial wearing course for future grinding of JPCP/CRCP.

(3) Portland cement concrete may be substituted for LCB when justified for constructibility or traffic handling. If Portland cement concrete is used in lieu of LCB, it must be placed in a separate lift than JPCP and must not be bonded to the JPCP.

(4) If ATPB is needed for TIs > 10.0 to perpetuate an existing treated permeable layer, place the ATPB between the surface layer (JPCP or CRCP) and the base layer. No deduction is made to the thickness of the base and subbase layers on account of the ATPB.

(5) Place a Bond Breaker between JPCP and LCB in all cases

(6) Traveled way and connectors.

(7) Ramps

LEGEND:

JPCP = Jointed Plain Concrete Pavement
CRCP = Continuously Reinforced Concrete Pavement
LCB = Lean Concrete Base
HMA-A = Hot Mix Asphalt (Type A)
ATPB = Asphalt Treated Permeable Base
AB = Class 2 Aggregate Base
TI = Traffic Index

Table 623.1I
Rigid Pavement Catalog (Desert, Type II Subgrade Soil) (1), (2), (3), (4), (5)

	Rigid Pavement Structural Depth			
TI	With Lateral Support (ft)		Without Lateral Support (ft)	
≤ 9	0.75 JPCP 1.00 AB		0.80 JPCP 1.00 AB	
9.5 to 10	0.80 JPCP 1.00 AB		0.90 JPCP 1.00 AB	
10.5 to 11	0.85 JPCP 1.30 AB		0.95 JPCP 1.30 AB	
11.5 to 12	0.80 CRCP (6) 0.25 HMA-A (6) 0.60 AS	0.90 JPCP (7) 1.30 AB (7)	0.85 CRCP (6) 0.25 HMA-A (6) 0.60 AS	1.00 JPCP (7) 1.30 AB (7)
12.5 to 13	0.85 CRCP 0.25 HMA-A 0.70 AS		0.95 CRCP 0.25 HMA-A 0.70 AS	
13.5 to 14	0.90 CRCP 0.25 HMA-A 0.70 AS		1.05 CRCP 0.25 HMA-A 0.70 AS	
14.5 to 15	0.95 CRCP 0.25 HMA-A 0.70 AS		1.10 CRCP 0.25 HMA-A 0.70 AS	
15.5 to 16	1.00 CRCP 0.25 HMA-A 0.70 AS		1.10 CRCP 0.25 HMA-A 0.70 AS	
16.5 to 17	1.05 CRCP 0.25 HMA-A 0.70 AS		1.10 CRCP 0.25 HMA-A 0.70 AS	
> 17	1.10 CRCP 0.25 HMA-A 0.70 AS		1.10 CRCP 0.25 HMA-A 0.70 AS	

NOTES:

(1) Thicknesses shown are for doweled JPCP only. Not valid for nondoweled JPCP.

(2) Includes 0.03 ft sacrificial wearing course for future grinding of JPCP/CRCP.

(3) Portland cement concrete may be substituted for LCB when justified for constructibility or traffic handling. If Portland cement concrete is used in lieu of LCB, it must be placed in a separate lift than JPCP and must not be bonded to the JPCP.

(4) If ATPB is needed for TIs > 10.0 to perpetuate an existing treated permeable layer, place the ATPB between the surface layer (JPCP or CRCP) and the base layer. No deduction is made to the thickness of the base and subbase layers on account of the ATPB.

(5) Place a Bond Breaker between JPCP and LCB in all cases

(6) Traveled way and connectors.

(7) Ramps

LEGEND:

JPCP = Jointed Plain Concrete Pavement
CRCP = Continuously Reinforced Concrete Pavement
LCB = Lean Concrete Base
HMA-A = Hot Mix Asphalt (Type A)
ATPB = Asphalt Treated Permeable Base
AB = Class 2 Aggregate Base
AS = Class 2 Aggregate Subbase
TI = Traffic Index

Table 623.1J
Rigid Pavement Catalog
(Low Mountain/South Mountain, Type I Subgrade Soil) (1), (2), (3), (4), (5)

TI	Rigid Pavement Structural Depth					
	With Lateral Support (ft)			Without Lateral Support (ft)		
≤ 9			0.75 JPCP 0.50 AB			0.75 JPCP 0.50 AB
9.5 to 10			0.75 JPCP 0.60 AB			0.85 JPCP 0.60 AB
10.5 to 11	0.75 JPCP BB 0.35 LCB	0.75 JPCP 0.25 HMA-A	0.80 JPCP 0.70 AB	0.85 JPCP BB 0.35 LCB	0.85 JPCP 0.25 HMA-A	0.90 JPCP 0.70 AB
11.5 to 12	0.80 JPCP BB 0.35 LCB	0.85 JPCP 0.25 HMA-A	0.80 CRCP 0.25 HMA-A	0.90 JPCP BB 0.35 LCB	0.95 JPCP 0.25 HMA-A	0.85 CRCP 0.25 HMA-A
12.5 to 13	0.90 JPCP BB 0.35 LCB	0.95 JPCP 0.25 HMA-A	0.85 CRCP 0.25 HMA-A	1.00 JPCP BB 0.35 LCB	1.05 JPCP 0.25 HMA-A	0.90 CRCP 0.25 HMA-A
13.5 to 14	0.95 JPCP BB 0.35 LCB	1.00 JPCP 0.25 HMA-A	0.85 CRCP 0.25 HMA-A	1.05 JPCP BB 0.35 LCB	1.10 JPCP 0.25 HMA-A	0.95 CRCP 0.25 HMA-A
14.5 to 15	1.00 JPCP BB 0.35 LCB	1.05 JPCP 0.25 HMA-A	0.90 CRCP 0.25 HMA-A	1.15 JPCP BB 0.35 LCB	1.20 JPCP 0.25 HMA-A	1.05 CRCP 0.25 HMA-A
15.5 to 16	1.05 JPCP BB 0.35 LCB	1.10 JPCP 0.25 HMA-A	0.95 CRCP 0.25 HMA-A	1.20 JPCP BB 0.35 LCB	1.25 JPCP 0.25 HMA-A	1.10 CRCP 0.25 HMA-A
16.5 to 17	1.10 JPCP BB 0.35 LCB	1.15 JPCP 0.25 HMA-A	1.00 CRCP 0.25 HMA-A	1.25 JPCP BB 0.35 LCB	1.30 JPCP 0.25 HMA-A	1.10 CRCP 0.25 HMA-A
> 17	1.15 JPCP BB 0.35 LCB	1.20 JPCP 0.25 HMA-A	1.00 CRCP 0.25 HMA-A	1.30 JPCP BB 0.35 LCB	1.35 JPCP 0.25 HMA-A	1.10 CRCP 0.25 HMA-A

NOTES:

(1) Thicknesses shown for JPCP are for doweled pavement only. The thickness shown in these tables are not valid for nondoweled JPCP.

(2) Includes 0.03 ft sacrificial wearing course for future grinding of JPCP/CRCP.

(3) Portland cement concrete may be substituted for LCB when justified for constructibility or traffic handling. If Portland cement concrete is used in lieu of LCB, it must be placed in a separate lift than JPCP and must not be bonded to the JPCP.

(4) If ATPB is needed for TIs > 10.0 to perpetuate an existing treated permeable layer, place the ATPB between the surface layer (JPCP or CRCP) and the base layer. No deduction is made to the thickness of the base and subbase layers on account of the ATPB.

(5) Place a Bond Breaker between JPCP and LCB in all cases

LEGEND:

JPCP = Jointed Plain Concrete Pavement
CRCP = Continuously Reinforced Concrete Pavement
LCB = Lean Concrete Base
HMA-A = Hot Mix Asphalt (Type A)
ATPB = Asphalt Treated Permeable Base
AB = Class 2 Aggregate Base
TI = Traffic Index
BB = Base Bond Breaker

Table 623.1K
Rigid Pavement Catalog
(Low Mountain/South Mountain, Type II Subgrade Soil) (1), (2), (3), (4), (5)

	Rigid Pavement Structural Depth					
TI	With Lateral Support (ft)			Without Lateral Support (ft)		
≤ 9			0.75 JPCP 1.00 AB			0.75 JPCP 1.00 AB
9.5 to 10			0.75 JPCP 1.00 AB			0.85 JPCP 1.00 AB
10.5 to 11	0.75 JPCP BB 0.35 LCB 0.60 AS	0.75 JPCP 0.25 HMA-A 0.60 AS	0.80 JPCP 1.30 AB	0.85 JPCP BB 0.35 LCB 0.60 AS	0.85 JPCP 0.25 HMA-A 0.60 AS	0.90 JPCP 1.30 AB
11.5 to 12	0.80 JPCP BB 0.35 LCB 0.60 AS	0.85 JPCP 0.25 HMA-A 0.60 AS	0.80 CRCP 0.25 HMA-A 0.60 AS	0.90 JPCP BB 0.35 LCB 0.60 AS	0.95 JPCP 0.25 HMA-A 0.60 AS	0.85 CRCP 0.25 HMA-A 0.60 AS
12.5 to 13	0.90 JPCP BB 0.35 LCB 0.70 AS	0.95 JPCP 0.25 HMA-A 0.70 AS	0.85 CRCP 0.25 HMA-A 0.70 AS	1.00 JPCP BB 0.35 LCB 0.70 AS	1.05 JPCP 0.25 HMA-A 0.70 AS	0.90 CRCP 0.25 HMA-A 0.70 AS
13.5 to 14	0.95 JPCP BB 0.35 LCB 0.70 AS	1.00 JPCP 0.25 HMA-A 0.70 AS	0.85 CRCP 0.25 HMA-A 0.70 AS	1.05 JPCP BB 0.35 LCB 0.70 AS	1.10 JPCP 0.25 HMA-A 0.70 AS	0.95 CRCP 0.25 HMA-A 0.70 AS
14.5 to 15	1.00 JPCP BB 0.35 LCB 0.70 AS	1.05 JPCP 0.25 HMA-A 0.70 AS	0.90 CRCP 0.25 HMA-A 0.70 AS	1.15 JPCP BB 0.35 LCB 0.70 AS	1.20 JPCP 0.25 HMA-A 0.70 AS	1.05 CRCP 0.25 HMA-A 0.70 AS
15.5 to 16	1.05 JPCP BB 0.35 LCB 0.70 AS	1.10 JPCP 0.25 HMA-A 0.70 AS	0.95 CRCP 0.25 HMA-A 0.70 AS	1.20 JPCP BB 0.35 LCB 0.70 AS	1.25 JPCP 0.25 HMA-A 0.70 AS	1.10 CRCP 0.25 HMA-A 0.70 AS
16.5 to 17	1.10 JPCP BB 0.35 LCB 0.70 AS	1.15 JPCP 0.25 HMA-A 0.70 AS	1.00 CRCP 0.25 HMA-A 0.70 AS	1.25 JPCP BB 0.35 LCB 0.70 AS	1.30 JPCP 0.25 HMA-A 0.70 AS	1.10 CRCP 0.25 HMA-A 0.70 AS
> 17	1.15 JPCP BB 0.35 LCB 0.70 AS	1.20 JPCP 0.25 HMA-A 0.70 AS	1.00 CRCP 0.25 HMA-A 0.70 AS	1.30 JPCP BB 0.35 LCB 0.70 AS	1.35 JPCP 0.25 HMA-A 0.70 AS	1.10 CRCP 0.25 HMA-A 0.70 AS

NOTES:

(1) Thicknesses shown for JPCP are for doweled pavement only. The thickness shown in these tables are not valid for nondoweled JPCP.

(2) Includes 0.03 ft sacrificial wearing course for future grinding of JPCP/CRCP.

(3) Portland cement concrete may be substituted for LCB when justified for constructibility or traffic handling. If Portland cement concrete is used in lieu of LCB, it must be placed in a separate lift than JPCP and must not be bonded to the JPCP.

(4) If ATPB is needed for TIs > 10.0 to perpetuate an existing treated permeable layer, place the ATPB between the surface layer (JPCP or CRCP) and the base layer. No deduction is made to the thickness of the base and subbase layers on account of the ATPB.

(5) Place a Bond Breaker between JPCP and LCB in all cases

LEGEND:

JPCP = Jointed Plain Concrete Pavement
CRCP = Continuously Reinforced Concrete Pavement
LCB = Lean Concrete Base
HMA-A = Hot Mix Asphalt (Type A)
BB = Base Bond Breaker
ATPB = Asphalt Treated Permeable Base
AB = Class 2 Aggregate Base
AS = Class 2 Aggregate Subbase
TI = Traffic Index

Table 623.1L
Rigid Pavement Catalog
(High Mountain/High Desert, Type I Subgrade Soil) (1), (2), (3), (4), (5)

	Rigid Pavement Structural Depth					
TI	With Lateral Support (ft)			Without Lateral Support (ft)		
≤ 9			0.85 JPCP 0.50 AB			0.90 JPCP 0.50 AB
9.5 to 10			0.90 JPCP 0.60 AB			0.95 JPCP 0.60 AB
10.5 to 11	0.90 JPCP BB 0.35 LCB	0.90 JPCP 0.25 HMA-A	0.95 JPCP 0.70 AB	0.95 JPCP BB 0.35 LCB	0.95 JPCP 0.25 HMA-A	1.00 JPCP 0.70 AB
11.5 to 12	0.95 JPCP BB 0.35 LCB	0.95 JPCP 0.25 HMA-A		1.05 JPCP BB 0.35 LCB	1.05 JPCP 0.25 HMA-A	
12.5 to 13	1.00 JPCP BB 0.35 LCB	1.05 JPCP 0.25 HMA-A		1.10 JPCP BB 0.35 LCB	1.15 JPCP 0.25 HMA-A	
13.5 to 14	1.05 JPCP BB 0.35 LCB	1.10 JPCP 0.25 HMA-A		1.15 JPCP BB 0.35 LCB	1.20 JPCP 0.25 HMA-A	
14.5 to 15	1.10 JPCP BB 0.35 LCB	1.15 JPCP 0.25 HMA-A		1.20 JPCP BB 0.35 LCB	1.25 JPCP 0.25 HMA-A	
15.5 to 16	1.15 JPCP BB 0.35 LCB	1.20 JPCP 0.25 HMA-A		1.25 JPCP BB 0.35 LCB	1.30 JPCP 0.25 HMA-A	
16.5 to 17	1.20 JPCP BB 0.35 LCB	1.25 JPCP 0.25 HMA-A		1.30 JPCP BB 0.35 LCB	1.35 JPCP 0.25 HMA-A	
> 17	1.25 JPCP BB 0.35 LCB	1.25 JPCP 0.25 HMA-A		1.35 JPCP BB 0.35 LCB	1.35 JPCP 0.25 HMA-A	

NOTES:

(1) Thicknesses shown for JPCP are for doweled pavement only. The thickness shown in these tables are not valid for nondoweled JPCP.

(2) Includes 0.15 ft sacrificial wearing course for future grinding of JPCP.

(3) Portland cement concrete may be substituted for LCB when justified for constructibility or traffic handling. If Portland cement concrete is used in lieu of LCB, it must be placed in a separate lift than JPCP and must not be bonded to the JPCP.

(4) If ATPB is needed for TIs > 10.0 to perpetuate an existing treated permeable layer, place the ATPB between the surface layer (JPCP or CRCP) and the base layer. No deduction is made to the thickness of the base and subbase layers on account of the ATPB.

(5) Place a Bond Breaker between JPCP and LCB in all cases

LEGEND:

JPCP = Jointed Plain Concrete Pavement
CRCP = Continuously Reinforced Concrete Pavement
LCB = Lean Concrete Base
HMA-A = Hot Mix Asphalt (Type A)
ATPB = Asphalt Treated Permeable Base
AB = Class 2 Aggregate Base
TI = Traffic Index
BB = Base Bond Breaker

Table 623.1M
Rigid Pavement Catalog
(High Mountain/High Desert, Type II Subgrade Soil) (1), (2), (3), (4), (5)

	Rigid Pavement Structural Depth					
TI	With Lateral Support (ft)			Without Lateral Support (ft)		
≤ 9			0.85 JPCP 1.00 AB			0.90 JPCP 1.00 AB
9.5 to 10			0.90 JPCP 1.00 AB			0.95 JPCP 1.00 AB
10.5 to 11	0.90 JPCP BB 0.35 LCB 0.60 AS	0.90 JPCP 0.25 HMA-A 0.60 AS	0.95 JPCP 1.30 AB	0.95 JPCP BB 0.35 LCB 0.60 AS	0.95 JPCP 0.25 HMA-A 0.60 AS	1.00 JPCP 1.30 AB
11.5 to 12	0.95 JPCP BB 0.35 LCB 0.60 AS	0.95 JPCP 0.25 HMA-A 0.60 AS		1.05 JPCP BB 0.35 LCB 0.60 AS	1.05 JPCP 0.25 HMA-A 0.60 AS	
12.5 to 13	1.00 JPCP BB 0.35 LCB 0.70 AS	1.05 JPCP 0.25 HMA-A 0.70 AS		1.10 JPCP BB 0.35 LCB 0.70 AS	1.15 JPCP 0.25 HMA-A 0.70 AS	
13.5 to 14	1.05 JPCP BB 0.35 LCB 0.70 AS	1.10 JPCP 0.25 HMA-A 0.70 AS		1.15 JPCP BB 0.35 LCB 0.70 AS	1.20 JPCP 0.25 HMA-A 0.70 AS	
14.5 to 15	1.10 JPCP BB 0.35 LCB 0.70 AS	1.15 JPCP 0.25 HMA-A 0.70 AS		1.20 JPCP BB 0.35 LCB 0.70 AS	1.25 JPCP 0.25 HMA-A 0.70 AS	
15.5 to 16	1.15 JPCP BB 0.35 LCB 0.70 AS	1.20 JPCP 0.25 HMA-A 0.70 AS		1.25 JPCP BB 0.35 LCB 0.70 AS	1.30 JPCP 0.23 HMA-A 0.70 AS	
16.5 to 17	1.20 JPCP BB 0.35 LCB 0.70 AS	1.25 JPCP 0.25 HMA-A 0.70 AS		1.30 JPCP BB 0.35 LCB 0.70 AS	1.35 JPCP 0.25 HMA-A 0.70 AS	
> 17	1.25 JPCP BB 0.35 LCB 0.70 AS	1.25 JPCP 0.25 HMA-A 0.70 AS		1.35 JPCP BB 0.35 LCB 0.70 AS	1.35 JPCP 0.25 HMA-A 0.70 AS	

NOTES:
(1) Thicknesses shown for JPCP are for doweled pavement only. The thickness shown in these tables are not valid for nondoweled JPCP.
(2) Includes 0.15 ft sacrificial wearing course for future grinding of JPCP.
(3) Portland cement concrete may be substituted for LCB when justified for constructibility or traffic handling. If Portland cement concrete is used in lieu of LCB, it must be placed in a separate lift than JPCP and must not be bonded to the JPCP.
(4) If ATPB is needed for TIs > 10.0 to perpetuate an existing treated permeable layer, place the ATPB between the surface layer (JPCP or CRCP) and the base layer. No deduction is made to the thickness of the base and subbase layers on account of the ATPB.
(5) Place a Bond Breaker between JPCP and LCB in all cases

LEGEND:
JPCP = Jointed Plain Concrete Pavement
CRCP = Continuously Reinforced Concrete Pavement
LCB = Lean Concrete Base
HMA-A = Hot Mix Asphalt (Type A)
BB = Base Bond Breaker
ATPB = Asphalt Treated Permeable Base
AB = Class 2 Aggregate Base
AS = Class 2 Aggregate Subbase
TI = Traffic Index

- Combination of corner, longitudinal, and traverse cracking and/or spalling between 1 and 15 percent of travel lane-miles. Note, corner, longitudinal, or transverse cracks that are at least ¾ inch in width. Also note, spalling is regarded as a joint or crack which spalls at least 6 inches wide as measured from centerline of joint or spall.

(3) All Concrete Pavements

- International Roughness Index (IRI) is more than 170 with no or minor distress.
- Faulting greater than ¼ inch.

CAPM strategies include the following or combinations of the following:

(a) Individual slab replacement (for JPCP) and punchout repair (for CRCP). The use of rapid strength concrete in the replacement of concrete slabs should be considered to minimize traffic impacts and open the facility to traffic in a minimal amount of time. Individual slab replacements and punchout repair may include replacing existing cement treated base or lean concrete base with rapid setting concrete lean concrete base or rapid strength concrete. For further information (including information on rapid strength concrete) see the Concrete Pavement Guide on the Department Pavement website.

(b) Spall repair. Spall repair is a corrective maintenance treatment that replaces loss of concrete, typically around joints or cracks, with polyester or fast-setting concrete. Depending on the existing pavement condition, spall repairs can be used as the primary project treatment or in combination with other preventive, corrective, or rehabilitation strategies. Typical cases when spall repair may be needed include repair of spalled joints and cracks on individual slab replacement projects, as a pre-overlay repair of a distress pavement surface, or prior to grinding or joint sealing projects.

(c) Grinding to correct faulting or poor ride. To improve ride quality, diamond grind the concrete pavement to correct ride smoothness to an acceptable level. If the existing pavement has an IRI > 170 inches per mile as determined by the Pavement Management System (PaveM), restore ride quality to an IRI of 60 inches per mile or less. If individual slab replacement is part of the project, diamond grind the concrete pavement after slab replacement is complete. The pavement must maintain an IRI of less than 170 inches per mile throughout its service life.

(d) Asphalt overlay strategies for CAPM in Index 635.2 may also apply to concrete pavement where appropriate.

The roadway rehabilitation requirements for overlays (see Index 625.1(2)) and preparation of existing pavement surface (Index 625.1(3)) apply to CAPM projects. Additional information regarding CAPM policies can be found in PDPM Appendix H and Design Information Bulletin (DIB) 81 "Capital Preventive Maintenance Guidelines." Additional details for scoping and designing these strategies can be found in the Concrete Pavement Guide. Both DIB 81 and the Concrete Pavement Guide can be found on the Department Pavement website.

Topic 625 - Engineering Procedures for Pavement Rehabilitation

625.1 Rehabilitation Warrants

A rehabilitation project is warranted if any of the following criteria is met:

Jointed Plain Concrete Pavement

- Number of slabs with 3rd stage cracking between 1 and 10 percent of a given travel lane-mile. Note, 3rd stage cracking is any slab with two or more intersecting cracks of ¾ inch in width.
- Combination of corner, longitudinal, and traverse cracking and/or spalling exceeding 15 percent of given travel lane-miles. Note, corner, longitudinal, or transverse cracks are at least ¾ inch in width. Also note, spalling is regarded as a joint or crack which spalls at least 6 inches wide as measured from centerline of joint or spall.
- When the number of slabs that warrant slab replacement per the above criteria is between

10 and 20 percent, perform a life cycle cost analysis per Topic 619 comparing roadway rehabilitation to CAPM. If CAPM has lower life cycle cost, pursue the project as a CAPM project.

625.2 Rigid Pavement Rehabilitation Strategies

(1) Strategies. An overview of rigid pavement strategies for rehabilitation is discussed in the "Concrete Pavement Guide," which can be found on the Department Pavement website. Some rehabilitation strategies discussed in the guide include the following or combinations of the following:

(a) Unbonded concrete overlay. To determine the thickness of the rigid layer, use the rigid layer thicknesses for new pavement found in Index 623.1. Include a 0.10 foot minimum asphalt interlayer between the existing pavement and rigid overlay. The interlayer may need to be thicker if it is used temporarily for traffic handling.

(b) Lane replacement. Lane replacements are engineered using the catalogs found in Index 623.1. Attention should be given to maintaining existing drainage patterns underneath the surface layer, (see Chapter 650 for further guidance). For further information see the Concrete Pavement Guide located on the Department Pavement website.

(c) Crack, seat, and asphalt overlay. Thicknesses should be engineered using Caltrans mechanistic-empirical method (CalME). See Index 635.2 for further details. Thicknesses for a 20-year and 40-year design life using this strategy have been provided in Table 625.2 for cost estimating purposes in planning documents when calculations are not available.

For crack, seat, and asphalt overlay projects, a nonstructural wearing course may be placed in addition to (but not as a substitute for) the thickness found in Table 625.2 for 20-year design life. A nonstructural wearing course is required for a 40-year design life. Once a rigid pavement has been cracked, seated, and overlaid with asphalt pavement it is considered to be a composite pavement and subsequent preservation and rehabilitation strategies are determined in accordance with the guidelines found in Chapter 640.

(d) Asphalt overlay (without crack and seat). If the existing rigid pavement (JPCP) will not be cracked and seated, for a 20-year design life, add an additional 0.10 foot HMA to the minimum standard thicknesses of HMA surface course layer given in Table 625.2. Since the maximum thickness for RHMA-G is 0.20 foot (see Index 631.3), no additional thickness is needed if RHMA-G is used for the overlay. For 40-year design life, if the existing pavement cannot be cracked and seated it will need to be removed or rubblized. The section should be designed as a flexible pavement per Index 633.1(3) or Caltrans mechanistic-empirical method (CalME) in Chapter 630.

(2) Overlay Limits. **On overlay projects, the entire traveled way and paved shoulder shall be overlaid.** Not only does this help provide a smoother finished surface, it also benefits bicyclists and pedestrians when they need to use the shoulder.

(3) Preparation of Existing Pavement. <u>Existing pavement distresses should be repaired before overlaying the pavement</u>. Cracks 3/8 inch or wider should be sealed; loose pavement removed and patched; spalls repaired; and broken slabs or punchouts replaced. Existing thermoplastic traffic striping and above grade pavement markers should be removed. This applies to both lanes and adjacent shoulders (flexible and rigid). The Materials Report should include a reminder of these preparations. Crack sealants should be placed ¼ inch below grade to allow for expansion (i.e., recess fill) and to alleviate a potential bump if an overlay is placed. For information and criteria for slab replacements, see the Concrete Pavement Guide located on the Department Pavement website.

(4) Selection. The selection of the appropriate strategy should be based upon life-cycle cost analysis, load transfer efficiency of the joints,

materials testing, ride quality, safety, maintainability, constructibility, visual inspection of pavement distress, and other factors listed in Chapter 610. The Materials Report should discuss any historical problems observed in the performance of rigid pavement constructed with aggregates found near the proposed project and subjected to similar physical and environmental conditions.

(5) *Smoothness.* For rehabilitation projects, restore the ride quality to an IRI of 60 inches per mile or less. Additional information on smoothness can be found on the pavement smoothness page on the Department Pavement website.

Topic 626 - Other Considerations

626.1 Traveled Way

(1) *Mainline.* No additional considerations.

(2) *Ramps and Connectors.* If tied rigid shoulders or widened slabs are used on the mainline, then the ramp or connector gore area (including ramp traveled way adjacent to the gore area) should also be constructed with rigid pavement (see Figure 626.1). This will minimize deterioration of the joint between the flexible and rigid pavement. When the ramp or connector traveled way is rigid pavement, utilize the same base and thickness for the gore area as that to be used under the ramp shoulders, especially when concrete shoulders are utilized on the mainline. Note that in order to optimize constructability, any concrete pavement structure used for mainline concrete shoulders should still be perpetuated through the gore area. If the base is Treated Permeable Base (TPB) under the ramp's traveled way and shoulder, TPB should still be utilized in the ramp gore areas as well.

(3) *Ramp Termini.* Rigid pavement is sometimes placed at ramp termini instead of flexible pavement where there is projected heavy truck traffic (as defined in Index 613.5(1)(c)) to preclude pavement failure such as rutting or shoving from vehicular braking, turning movements, and oil dripping from vehicles. Once a design TI is selected for the ramp in accordance with Index 613.5, follow the requirements in Index 623.1 to engineer the rigid pavement structure for the ramp termini. The length of rigid pavement to be placed at the termini will depend on the geometric alignment of the ramp, ramp grades, and the length of queues of stopped traffic. The rigid pavement should extend to the first set of signal loops on signalized intersections. A length of 150 feet should be considered the minimum on unsignalized intersections. Special care should be taken to assure skid resistance in conformance with current standard specifications in the braking area, especially where oil drippage is concentrated. End anchors or transitions should be used at flexible/rigid pavement joints. The Department Pavement website has additional information and training for engineering pavement for intersections and rigid ramp termini.

626.2 Shoulder

The types of shoulders that are used for rigid pavements are shown in Figure 626.2A and can be categorized into the following three types:

(1) *Tied Concrete Shoulders.* These are shoulders that are built with rigid pavement that are tied to the adjacent lane with tie bars. These shoulders provide lateral support to the adjacent lane, which improves the long-term performance of the adjacent lane, reducing the need for maintenance or repair of the lane. To obtain the maximum benefit, these shoulders should be built monolithically with the adjacent lane (i.e., no construction joints). This will create aggregate interlock between the lane and shoulder, which provides increased lateral support.

The pavement structure for the tied rigid shoulder should match the pavement structure of the adjacent traffic lane at the edge of traveled way. Special delineation of concrete shoulders may be required to deter the use of the shoulder as a traveled lane. District Traffic Operations should be consulted to determine the potential need for anything more than the standard edge stripe.

The locations to use tied concrete shoulders is discussed under Selection Criteria of this Index. Tied concrete shoulders are also the most adaptable to future widening and conversion to

Table 625.2

Thicknesses for Crack, Seat, and Flexible Overlay

<table>
<tr><td rowspan="2">20-year (1)</td><td>TI <12.0</td><td>0.35′ HMA
GPI or
RPI
0.10′ HMA (LC)</td><td>0.35′ HMA
GPI or RPI
0.10′ HMA (LC)</td><td>0.20′ RHMA-G
RPI
0.10′ HMA (LC)</td></tr>
<tr><td>TI ≥12.0</td><td>0.40′ HMA
GPI or RPI
0.15′ HMA (LC)</td><td>0.20′ RHMA-G
RPI
0.15′ HMA (LC)</td><td>0.20′ RHMA-G
0.15′ HMA
GPI or RPI
0.10′ HMA (LC)</td></tr>
<tr><td rowspan="2">40-year</td><td>TI ≥15.0</td><td>0.10′ HMA-O or
RHMA-O
0.20′ HMA (PM)
0.50′ HMA
GPI or RPI
0.10′ HMA (LC)</td><td></td><td>0.10′ RHMA-O
0.20′ RHMA-G
0.50′ HMA
GPI or RPI
0.10′ HMA (LC)</td></tr>
<tr><td>TI 12 - 15</td><td>0.10′ HMA-O or
RHMA-O
0.20′ HMA (PM)
0.35′ HMA
GPI or RPI
0.10′ HMA (LC)</td><td></td><td>0.10′ RHMA-O
0.20′ RHMA-G
0.35′ HMA
GPI or RPI
0.10′ HMA (LC)</td></tr>
</table>

NOTE:

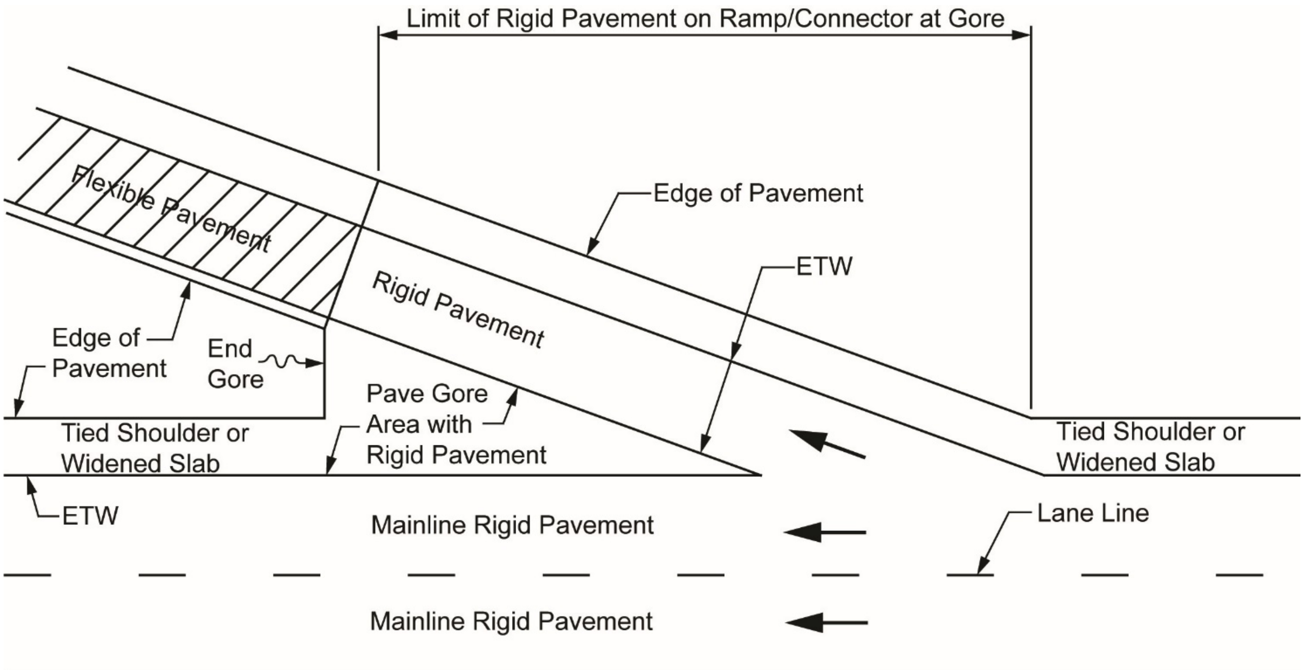
(1) If the existing rigid pavement is not cracked and seated, add minimum of 0.10 foot HMA over the GPI layer.

Legend:

HMA = Hot Mix Asphalt
HMA (LC) = Hot Mix Asphalt Leveling Course
HMA (PM) = Hot Mix Asphalt Modified Binder
RHMA-G = Rubberized Hot Mix Asphalt (Gap Graded)
GPI = Geosynthetic Pavement Interlayer
RPI = Rubberized Pavement Interlayer

Figure 626.1

Preferred Limits of Rigid Pavement at Flexible Pavement Ramp or Connector Gore Area



NOTES:

(1) Not all details shown.

(2) Off ramp shown. Same conditions apply for on ramps.

a lane. Where there is an identified documented plan (such as Regional Transportation Plan, Metropolitan Transportation Plan and Interregional Transportation Plan) to convert the shoulder into a traffic lane within the next 20 years, the shoulder may be built to the same geometric and pavement standards as the lane. See Index 613.5(2) for criteria and requirements.

(2) *Widened Slab.* Widened slabs involve constructing the concrete panel for the lane adjacent to the shoulder 14 feet wide on the outside and 13 feet wide on the inside in lieu of the prescribed lane width. The additional width becomes part of the shoulder width and provides lateral support to the adjacent lane. Widened slabs provide as good or better lateral support than tied rigid shoulders at a lower initial cost provided that trucks and buses are kept away from the edge of the slab. A rumble strip or a raised pavement marking next to the pavement edge line of widened concrete slabs helps discourage trucks and buses from driving on the outside 2 feet of the slab. The use of rumble strips or raised markings requires approval from District Traffic Operations.

Widened slabs are most useful in areas where lateral support is desired but future widening is not anticipated.

(3) *Untied Shoulders.* Untied shoulders are shoulders (typically flexible) that are not built with a widened slab or rigid shoulders that are not tied to the adjacent lane and not built adjacent to a widened slab. These shoulders do not provide lateral support to the adjacent lane. Although non-supported shoulders may have lower initial costs, they do not perform as well as tied rigid shoulders or widened slabs, which can lead to higher maintenance costs, user delays, and life-cycle costs. Untied shoulders may be used as an alternative to widened lanes where future widening is identified in a regional, metropolitan, or interregional transportation plan within 20 years.

(4) *Selection Criteria.* It is preferred that shoulders be constructed of the same material as the traveled way pavement (in order to facilitate construction, improve pavement performance, and reduce maintenance cost). Shoulders adjacent to rigid pavement traffic lanes can be either rigid or flexible with the following conditions:

(a) Tied concrete shoulders shall be used for:

- **rigid pavements constructed in the High Mountain and High Desert climate regions (see climate map in Topic 615).**
- **paved buffers between rigid High-Occupancy Vehicle (HOV) lanes and rigid mixed flow lanes. Same for High-Occupancy Toll (HOT) lanes.**
- **rigid ramps to and from truck inspection stations.**

(b) Either tied concrete shoulders or widened slabs shall be used for:

- **continuously reinforced concrete pavement.**
- **horizontal radii 300 feet or less.**
- **truck and bus only lanes.**
- **desert climate regions. Where widened slabs are used, the remaining shoulder width shall also be concrete pavement.**

Where tied concrete shoulders or widened slabs are used, they shall continue through ramp and gore areas (see Figure 626.2B). Paving the gore area and adjacent ramp with concrete is preferred (see Figure 626.1).

The shoulder pavement structure selected must meet or exceed the pavement design life standards in Topic 612 and meet requirements for shoulders in Index 613.5(2). Table 626.2 and Figure 626.2C show rigid pavement shoulder design thicknesses for widened slabs and untied shoulders which meet these requirements. For untied concrete shoulders and portions of shoulders built within widened lane, use the thicknesses in Tables 626.2B-M.

In those instances where flexible shoulders are used with rigid pavement, the minimum flexible shoulder thickness should be determined in accordance with Topic 633.

These conditions apply to all rigid pavement projects including new construction, reconstruction, widening, adjacent lane replacements, and shoulder replacements. Typically existing asphalt shoulders next to concrete pavement are not replaced for preservation projects that involve only grinding, dowel bar retrofits punchout repairs, and individual slab replacements. For rehabilitation projects, the goal is to maintain existing shoulders where possible using preservation treatments. For conditions where to consider shoulder replacement, see Index 613.5(2)(e).

In selecting whether to construct concrete or asphalt shoulders the following factors should be considered:

- Life-cycle cost of the shoulder.
- Ability and safety of maintenance crews to maintain the shoulder. In confined areas, such as in front of retaining walls or narrow shoulders, and on high volume roadways (AADT > 150,000) consideration should be given to engineering concrete shoulders, even if it is more expensive to construct.
- Width of shoulder.
- For projects where the tracking width lines are shown to encroach onto paved shoulders or any portion of the gutter pan, tied rigid shoulders and the gutter pan structure must be engineered to sustain the weight of the design vehicle. See Topic 404 for design vehicle guidance.

See Index 1003.5(1)) for surface quality guidance for shoulders on highways open to bicyclists.

626.3 Intersections

Standard joint spacing patterns found in the Standard Plans do not apply to intersections. Special paving details for intersections need to be included in the project plans. Special consideration needs to be given to the following features when engineering a rigid pavement intersection:

- Intersection limits.
- Joint types and joint spacing.
- Joint patterns.
- Slab dimensions.
- Pavement joints at utilities.
- Dowel bar and tie bar placement.

Additional information and training is available on the Department Pavement website.

626.4 Roadside Facilities

(1) *Safety Roadside Rest Areas and Vista Points.* If rigid pavement is selected for some site-specific reason(s), the pavement structures used should be sufficient to handle projected loads at most roadside facilities. To select the pavement structure, determine the Traffic Index either from traffic studies and projections developed for the project or the values found in Table 613.5B, whichever is greater. Then select the appropriate pavement structure from the catalog in Index 623.1. Treated bases such as lean concrete base and hot mix asphalt base should not be used for Traffic Indices less than 12.

Joint spacing patterns found in the Standard Plans do not apply to parking areas. Joint patterns should be engineered as square as possible. Relative slab dimensions should be approximately 1:1 to 1:1.25, transverse-to-longitudinal. Transverse and longitudinal joints should be perpendicular to each other. Joints should be doweled in two directions. Special attention should be given to joint patterns around utility covers and manholes.

Use guidelines for intersections in Index 626.3 for further information.

(2) *Bicycle Facilities.* For bicycle facilities independent of the vehicular roadway use local standards where available and where local agencies will be maintaining the facility. Otherwise, for stand-alone bike paths, use the following thicknesses:

- 0.35 foot minor concrete and 0.50 foot aggregate base for bike paths not available to maintenance vehicles, or
- 0.50 foot minor concrete and 0.50 foot aggregate base for bike paths accessible to maintenance vehicles.

Place longitudinal joints at centerline for 2-way bikeways and no more than 8 feet for one way bikeways. Transverse joints should be placed such that the transverse slab dimension relative to longitudinal dimension is between 1:1 and 1:1.25. Construction is similar to sidewalks or pathways so dowel bars and tie bars should not be used.

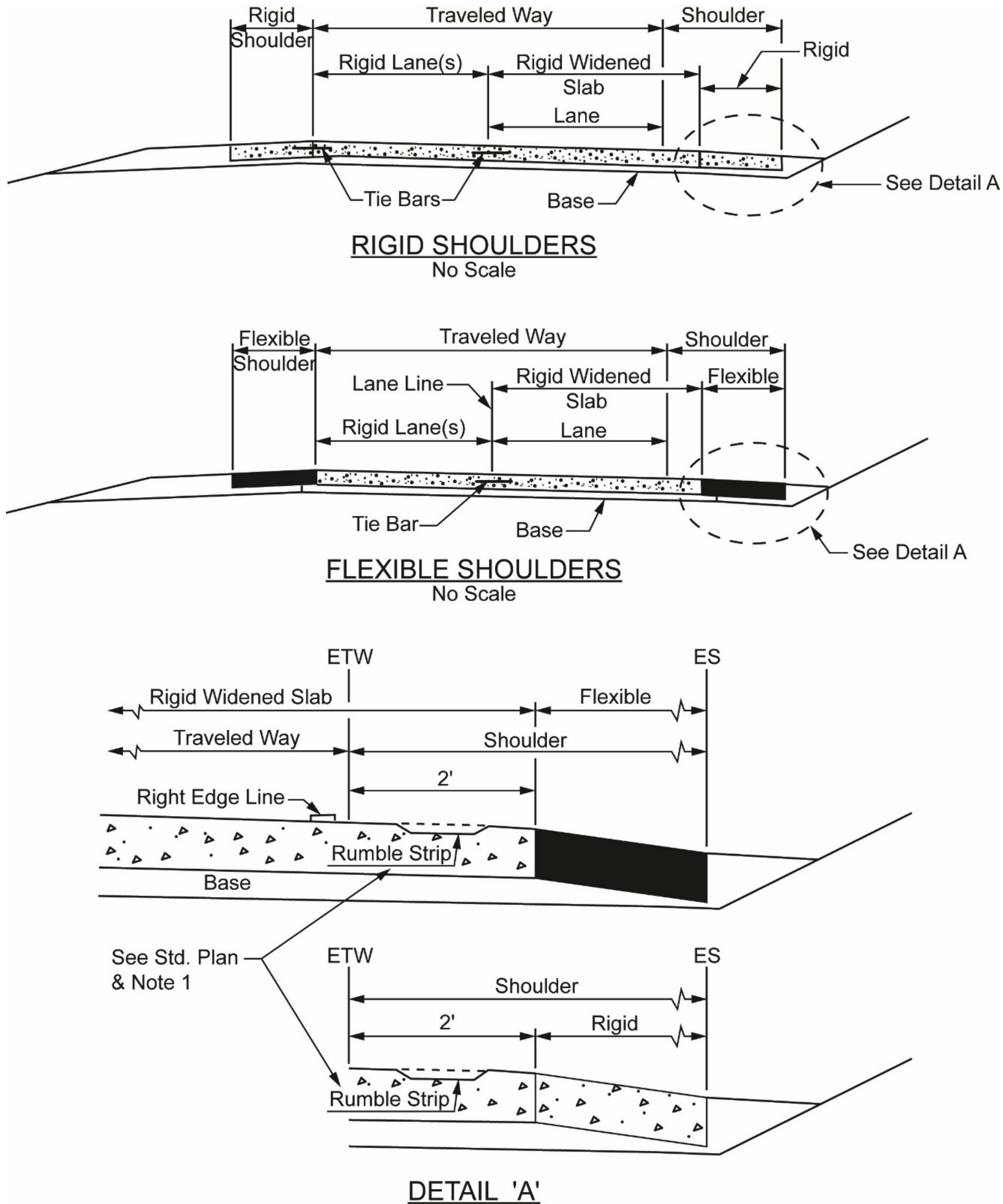
(3) *Bus Pads.* Bus pads are subjected to similar stresses as intersections; however, it is not practical to engineer rigid bus pads according to the Traffic Index, or according to bus counts. The minimum pavement structure for bus pads should be 0.85 foot JPCP with dowel bars at transverse joints on top of 0.5 foot lean aggregate subbase (0.65 foot PPCP may be substituted for 0.85 foot JPCP). Type III soil should be treated in accordance with Index 614.4. Where local standards are more conservative than the pavement structures mentioned above, local standards should govern.

Relative slab dimensions for bus pads should be approximately 1:1 to 1:1.25, transverse-to-longitudinal. The width of the bus pad should be no less than the width of the bus plus 4 feet. If the bus pad extends into the traveled way, the rigid bus pad should extend for the full width of the lane occupied by buses. The minimum length of the bus pad should be 1.5 times the length of the bus(es) that will use the pad at any given time. This will provide some leeway for variations in where the bus stops. Additional length of rigid pavement should be considered for approaches and departures from the bus pad since these locations may be subjected to the same stresses from buses as the pad. A 115-foot length of bus pad (which is approximately 250 percent to 300 percent times the length of typical 40-foot buses) should provide sufficient length for bus approach and departure. The decision whether to use rigid pavement for bus approach and departure to/from bus pads is the responsibility of the District.

A JPCP end anchor is not required, but may improve long-term performance at the flexible-to-rigid pavement transition. Doweled transverse joints should be perpendicular to the longitudinal joint at maximum 15 feet spacing, but consider skewing (at 1:6 typical) entrance/exit transverse flexible-to-rigid transitions, note that since acute corners can fail prematurely, acute corners should be rounded (see Figure 626.4). Special care should be taken to assure skid resistance in conformance with current Standard Specifications in the braking area, especially where oil drippage is concentrated.

Figure 626.2A

Rigid Pavement and Shoulder Details Nomenclature Illustration



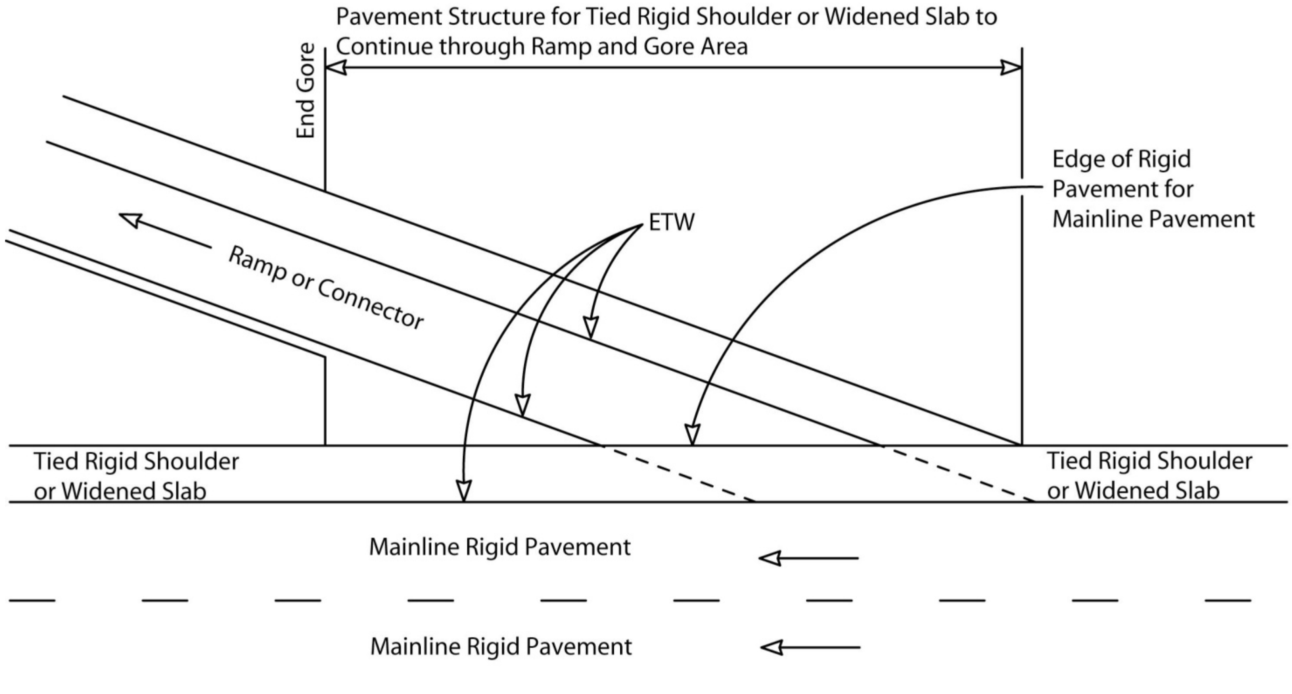
NOTES:

(1) Use of rumble strips is determined in consultation with District Traffic Operations.

(2) Right side widened slab is shown. Left side widened slab is similar.

Figure 626.2B

Rigid Shoulders Through Ramp and Gore Areas

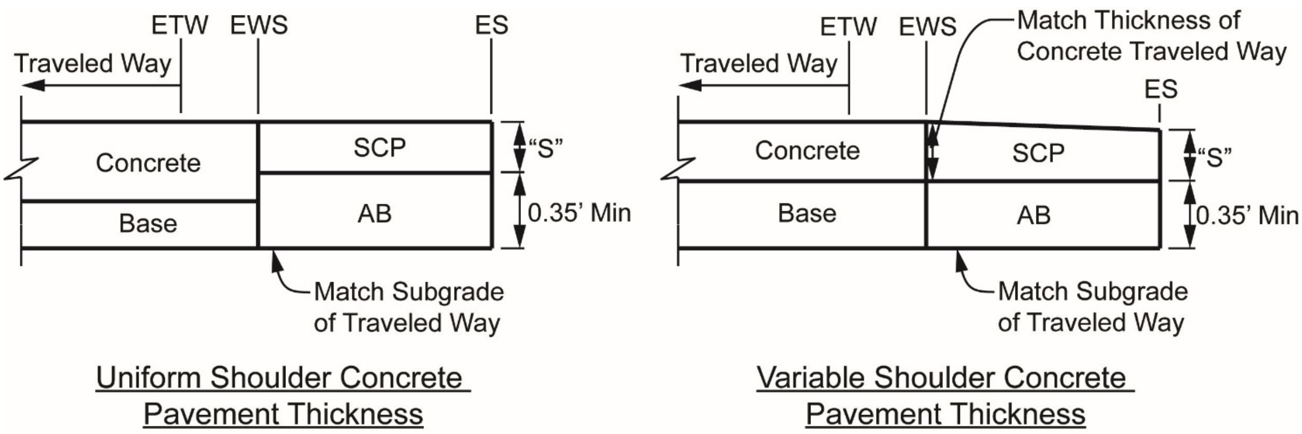


NOTES:

(1) Not all details shown.
(2) Off ramp shown. Same conditions apply for on ramps.

Figure 626.2C

Widened Slab Shoulder with Concrete Remainder Designs



NOTES:

No Scale
"S" = Shoulder Concrete Pavement thickness dimension
SCP = Shoulder Concrete Pavement
AB = Aggregate Base
TI = Traffic Index
ETW = Edge of traveled way
EWS = Edge of widened slab
ES = Edge of shoulder

Table 626.2

Shoulder Concrete Pavement Designs ("S" Dimension)

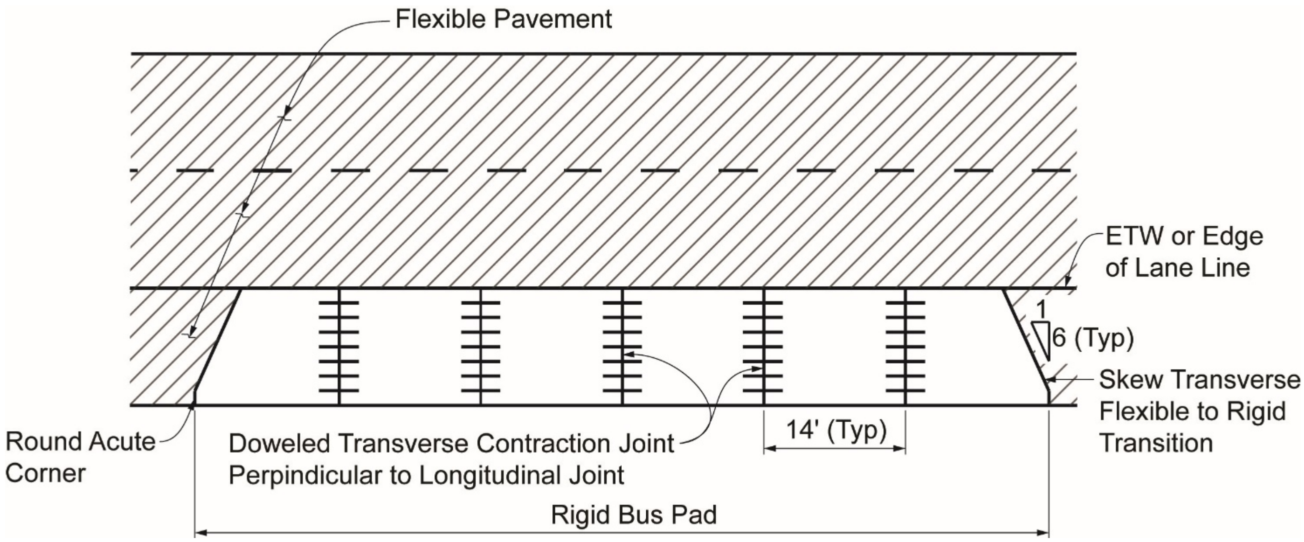
Climate Region	S (Based on TI ≤ 9, unsupported edge)
North Coast	0.70
South Coast / Central Coast	0.75
Inland Valley	0.80
Desert	0.80
Low Mountain / South Mountain	0.75
High Mountain / High Desert	0.90

NOTES:

(1) For use with widened lanes or untied shoulders only

Figure 626.4

Rigid Bus Pad



NOTES:

(1) Not all details shown.